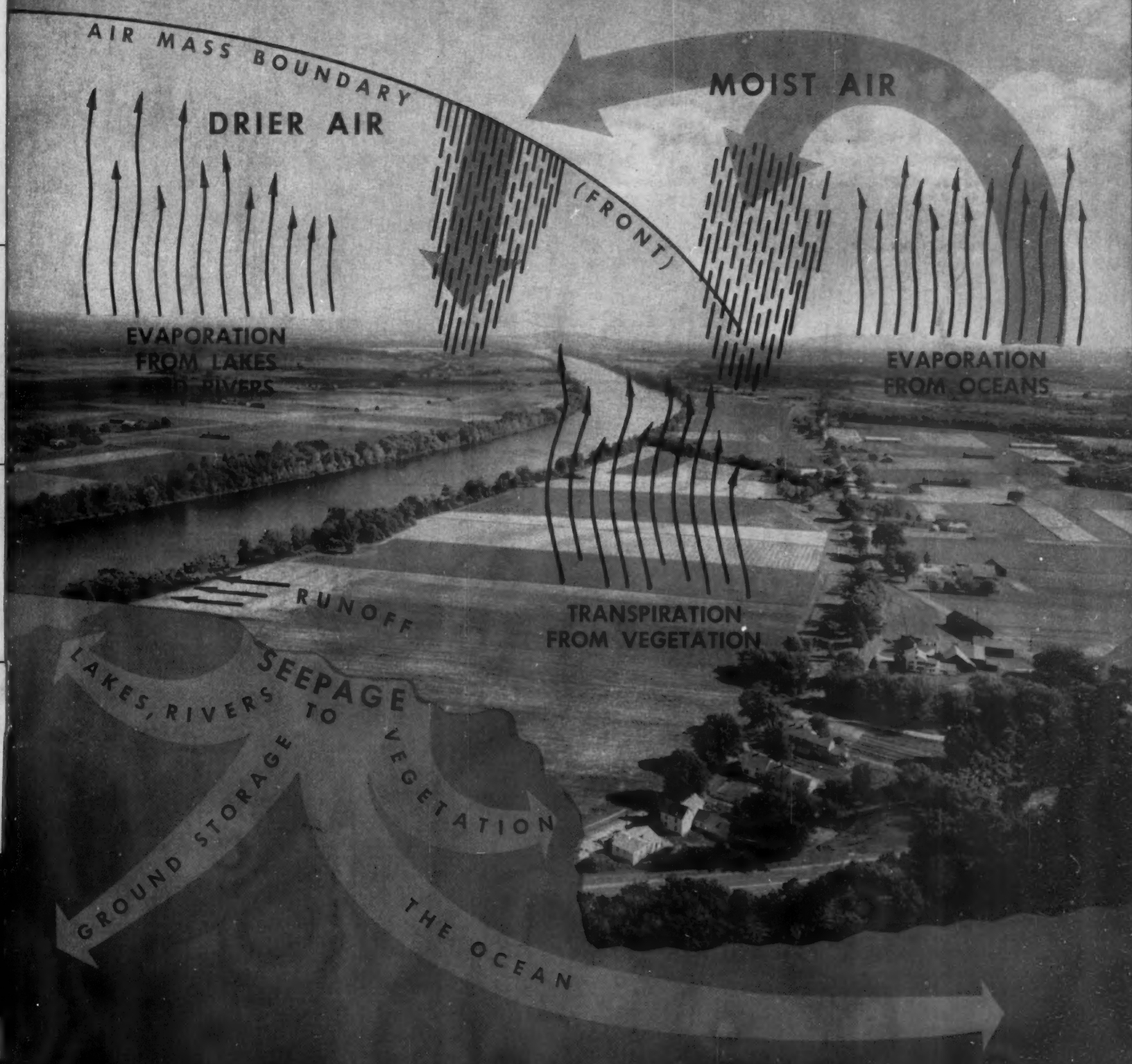


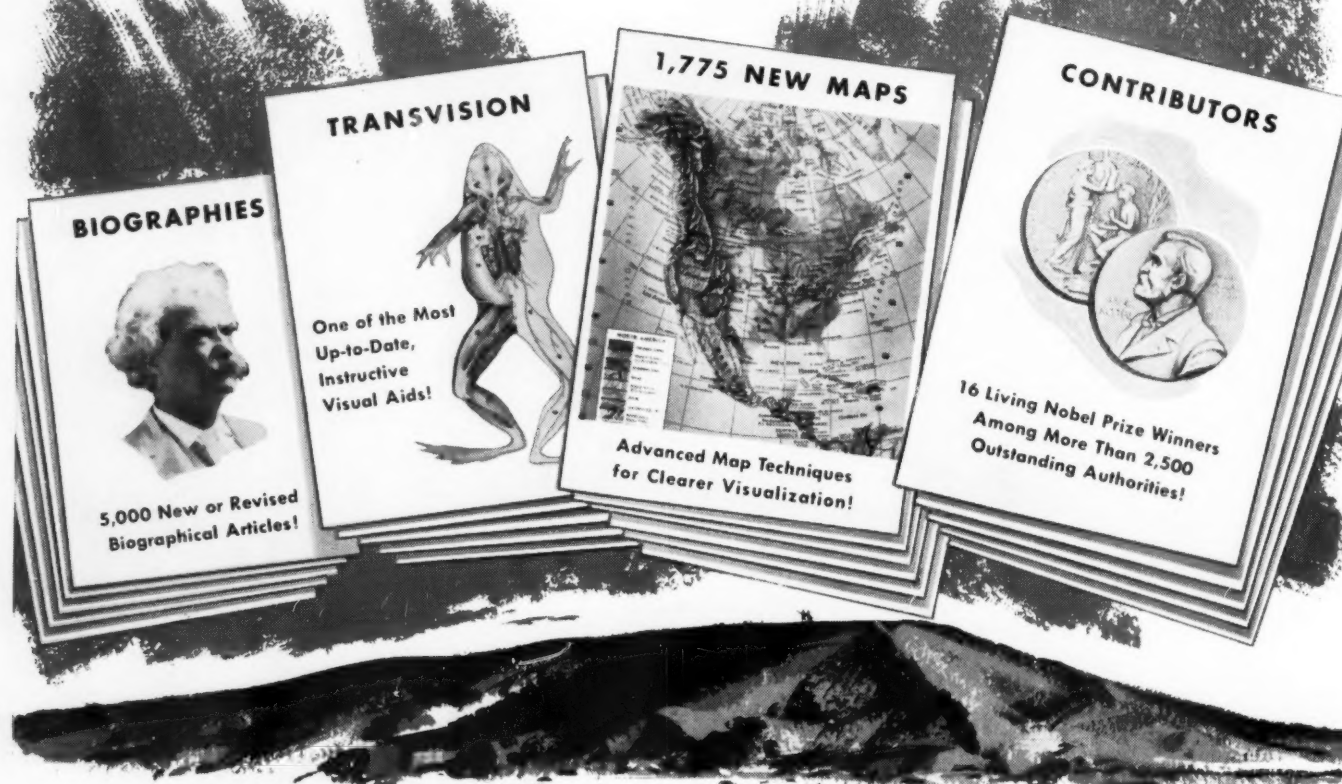
THE SCIENCE TEACHER

VOLUME 27, NUMBER 2 • MARCH 1960



Here now! To help you...

Every Change... *Important*
Every Advantage... *Definite*



The 1960 WORLD BOOK ENCYCLOPEDIA

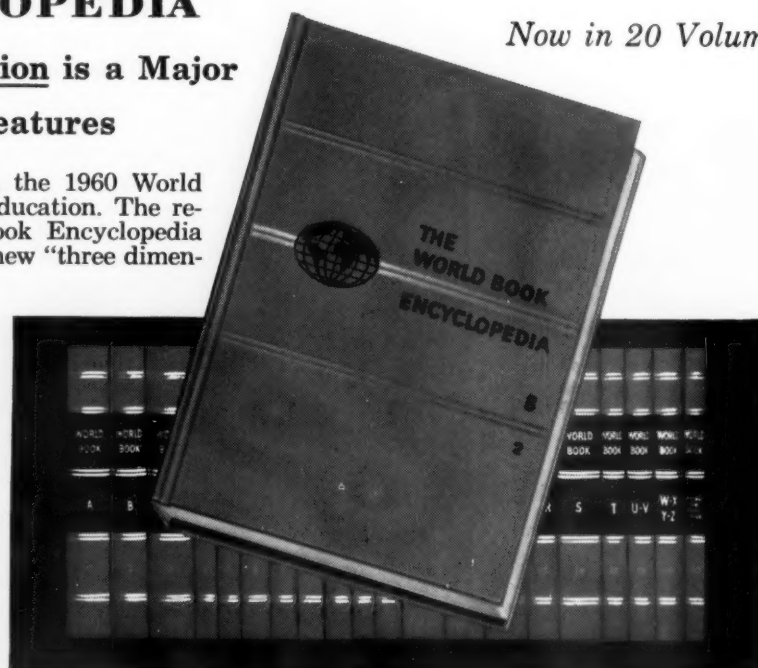
Now in 20 Volumes

This Greatly Enlarged New Edition is a Major Revision With Many Exclusive Features

More than an exciting editorial achievement, the 1960 World Book makes important new contributions to education. The revised and expanded twenty-volume World Book Encyclopedia offers tested visual aids such as Transvision, a new "three dimensional" map program, and thousands of new or revised articles. New illustrations are more interesting, more numerous than ever before. In fact, no other reference set has ever been more precisely organized and systematically revised to help educators and students.

The 1960 World Book Encyclopedia represents an investment of an *additional* \$2,800,000 in creative costs to make available to schools, libraries, and homes the most modern, accurate, and useful reference set. Write for complete information without obligation.

Field Enterprises Educational Corporation
Merchandise Mart Plaza, Chicago 54, Illinois



Outstanding books for your science program—



Chemistry for Our Times

New Third Edition (1960)

**Weaver
and
Foster**

Thoroughly revised to include all the latest developments. New emphasis on principles. A transvision of a nuclear power plant. New two-color end-papers. Many new illustrations. Each new topic begins with phenomena familiar to the student and moves on to related chemical facts and principles. Laboratory Manual, Test Booklet, Correlated Filmstrips, and Teacher's Manual available.

Using Chemistry

1959 Edition

**Oscar
E.
Lanford**

A solid principles book, geared to the exacting standards of present-day science requirements. New material reflects recent developments. Emphasis throughout is on principles. Laboratory Manual, Test Booklet, and Teacher's Manual available.

Physics for Our Times

1958 Edition

Marburger and Hoffman

The Earth and Its Resources

Third Edition (1959)

Finch, Trewartha, and Shearer

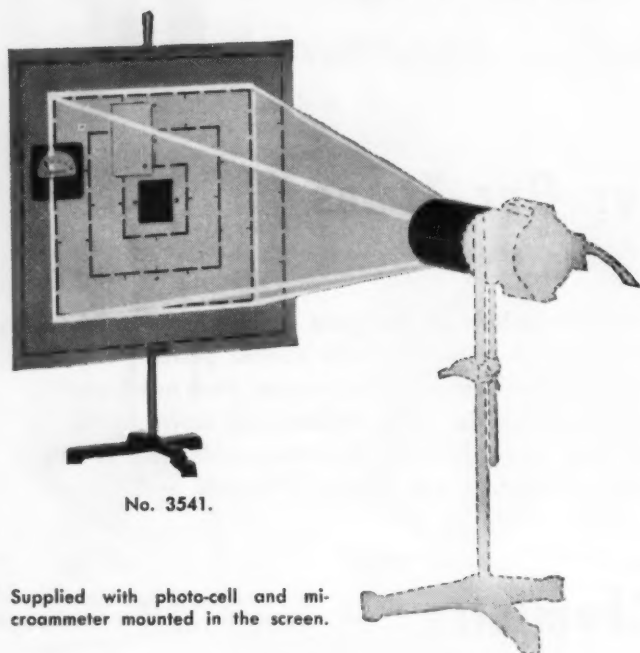
Write for information to School Department

McGraw-Hill Book Company

New York 36 • Chicago 46 • Dallas 2 • San Francisco 4

NEW!

WELCH



Photoelectric INVERSE SQUARE LAW APPARATUS

For Use As A Student
Laboratory Experiment
Or A Classroom
Demonstration

Apparatus adapted from one originally developed by Joseph Singerman, Queen's College, Brooklyn, and High School of Commerce, New York City.

Gives an unusually clear demonstration of the INVERSE SQUARE LAW FOR LIGHT

Enables the student to verify the law quantitatively

Darkened room is desirable but complete darkness not necessary if test surface is reasonably well screened from direct rays of light and highly reflective surfaces

Designed for use with Welch No. 3680 Source of Light which is a required accessory and for which a special adapter with a square aperture is included

Primarily intended for laboratory use by a small group of students. Can be used before a large class by connecting an auxiliary lecture-table galvanometer to the photocell in place of the small panel meter on the test surface, or the values from the meter may be recorded on the blackboard.

- No. 3541.** Inverse Square Law Apparatus consisting of a screen 44x44 cm with a photocell and microammeter mounted therein, adjustable in height on its support, and an adapter for No. 3680 Light Source.....Each **\$50.00**
- No. 3680.** Source of Light for use with No. 3541.....Each **\$26.75**
- No. 2692X.** High Sensitivity Lecture-Table Galvanometer (for use in class demonstrations)Each **\$178.50**

WRITE FOR COMPLETE CIRCULAR

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 SEDGWICK STREET, DEPT. C-3, CHICAGO 10, ILLINOIS, U.S.A.

THE SCIENCE TEACHER

STAFF

Editor.....ROBERT H. CARLETON
Associate Editor
and Advertising.....FRANCES J. LANER
Staff Assistants.....JACQUELYN A. FISH
S. JUSTINE BURTON
Circulation and
Subscriptions.....GEORGE A. CROSBY
Memberships.....EDITH M. NICHOLAS

ADVISORY BOARD

RICHARD SALINGER (1960) *Chairman*
Wilton High School, Wilton, Connecticut
ALFRED B. BUTLER (1961)
Washington State University, Pullman,
Washington
MILDRED EINZIG (1961)
Cleveland Public Schools, Cleveland,
Ohio
HOWARD P. MCCOLLUM (1962)
State Department of Education,
Baton Rouge, Louisiana
JAMES A. RUTLEDGE (1962)
University of Nebraska, Lincoln,
Nebraska
DOROTHY VAUGHN (1960)
Neodesha High School, Neodesha,
Kansas

SCIENCE CONSULTANTS

WILLIAM JONES BOWEN, National Institutes
of Health, *Biology*
LEO SCHUBERT, American University,
Chemistry
JOHN S. TOLL, University of Maryland,
Physics

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association Volume 27, Number 2 • March 1960

FACETS OF CLIMATE <i>H. E. Landsberg</i>	6
DIFFICULT CONCEPTS IN BEGINNING CHEMISTRY <i>Grant W. Smith</i>	15
BIOLOGY ACHIEVEMENT IN GRADES 9 AND 10 Report of Test Scores in Biology by Students in the Denver Public Schools <i>George E. Mathes and Sam Blanc</i>	23
MORE ON NINTH GRADE BIOLOGY <i>Lloyd H. Heidgerd</i>	27
SPECIAL REPORT ON THE DARWIN CENTENNIAL CELEBRATION ONE HUNDRED YEARS LATER <i>Abraham Raskin</i>	31
A BLOOD RESEARCH PROJECT WITH GIFTED STUDENTS <i>Ethelreda Laughlin</i>	39
THE ELEMENTARY SCHOOL SCIENCE CURRICULUM <i>J. Myron Atkin</i>	51
SPOTLIGHT ON RESEARCH Research on the Teaching of Elementary School Science <i>Paul C. Burns</i>	48
CLASSROOM IDEAS Self-Raising Weights on Pulley Systems <i>Walter Eisenberg</i>	63
Velocity of Sound in Air by Resonance, Experiment 1 Total Energy of Motion of the Earth, Experiment 2 <i>Julius Sumner Miller</i>	65
ANNOUNCEMENT—NEW DEVELOPMENTS IN HIGH SCHOOL SCIENCE TEACHING.....	55
BOOK REVIEWS.....	73
SCIENCE TEACHING MATERIALS Book Briefs.....	75
Professional Reading.....	80
Audio-Visual Aids.....	81
Apparatus and Equipment.....	81
EDITORIAL.....	4
LETTERS.....	5
CONVENTION CAPSULES.....	57
NSTA ACTIVITIES.....	69
FSA ACTIVITIES.....	71
NSTA CALENDAR.....	65
INDEX OF ADVERTISERS.....	82



Members of NSTA frequently write to tell us how much they appreciate the many services and materials that in their opinions "hit the bull's eye."

Many behind-the-scenes activities of NSTA also are striking some important targets. Being beyond the scope of direct services to members, however, it is somewhat of a problem to communicate fully the nature and significance of these endeavors. The "NSTA Activities" and "FSA Activities" pages of *TST* carry such reports in each issue. But there is so much going on I believe we can use this column to good advantage this month in brief descriptions of several current efforts and projects.

First, in the realm of facilities for the teaching of science, NSTA with the collaboration of two other agencies has held exploratory seminars on (a) implications for facilities of trends and new dimensions in

science education, and (b) the role of kits, models, and scientific toys in learning about science.

How much science are boys and girls learning (and how good is it) through the materials now being made available by the multimillion dollar scientific toy-model-kit industry? What are the implications for classroom instruction in science? To what extent should our profession attempt to develop criteria and guidelines for selection and use, both by teachers in school and by parents outside of school? What changes in classroom and laboratory design and furnishings during the next decade are called for by current tendencies to accelerate the science program, and to provide seminars, research-type opportunities, and advanced courses for able students in grades 11-14? These are indicative of the questions considered in the seminars. Decisions on follow-up actions, if any, from the seminars are still pending.

Another important role of NSTA is that of cooperation with other professional societies. Three diverse examples can be cited.

1. NSTA has provided an official representative of high school physics teaching to meet with the advisory committee for a project on the design of physics buildings. The project is being carried on by the American Association of Physics Teachers.

2. NSTA has joined three scientific societies in the formation of the Metallurgy-Ceramics Foundation to deal with problems of education in these fields at both secondary and collegiate levels.

3. Within the NEA family, NSTA now has under way a joint project with the Department of Elementary School Principals. This will produce a booklet on science for parents of elementary-age youngsters. NSTA has joined with some 20 other NEA units also to form a Council on Instruction, an agency to study the over-arching problems that transcend subject matter and department boundaries. (The NSTA Executive Secretary is chairman of the group this year.)

Still another area which NSTA is exploring is a program in the field of international activities. Foreign visitors are constantly seeking data from us and the U. S. Office of Education on science programs in America. The forthcoming European tour by some 30 representatives of NSTA and science teachers of America may crystallize more fully our responsibilities in this field.

NSTA participation in these and other similar programs has been considered and approved, in line with policies of the Board of Directors. It is believed that these efforts can contribute significantly to the advancement of science education.

Magazines, packets, conventions, and projects as those mentioned above are among the services an organized profession can achieve. These are the projects in which NSTA participates through the support of 14,000 members—for their benefit and for the benefit of 50,000 other science teachers and their students.

Robert H. Carleton

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association monthly except January, June, July, and August. Editorial and executive offices, 1201 Sixteenth Street, N.W., Washington 6, D. C. Of the membership dues (see listing below) \$3 is for the Journal subscription. Single copies, \$1.00. Copyright, 1960 by the National Science Teachers Association. Second-class postage paid at Washington, D. C. Printing and typography by Judd & Detweiler, Inc., Washington, D. C.

Articles published in *The Science Teacher* are the expressions of the writers. They do not, however, necessarily represent the policy of the Association or the Magazine Advisory Board.

OFFICERS OF THE ASSOCIATION

DONALD G. DECKER, *President*, Colorado State College, Greeley, Colorado

ROBERT A. RICE, *President-elect*, Berkeley High School, Berkeley, California

HERBERT A. SMITH, *Retiring President*, University of Kansas, Lawrence, Kansas

SYLVIA NEIVERT, *Secretary*, Bay Ridge High School, Brooklyn, New York

J. DONALD HENDERSON, *Treasurer*, University of North Dakota, Grand Forks, North Dakota

ROBERT H. CARLETON, *Executive Secretary*, 1201 Sixteenth Street, N. W., Washington 6, D. C.

MEMBERSHIP

The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

Regular Membership	\$ 6.00
Sustaining Membership *	10.00
Student (college and university) Membership	2.00
Life Membership *	175.00
Payable in ten annual installments; \$150 if paid in three years or less.	
Library Subscriptions *	8.00

* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

***** Have you applied for Your share of FEDERAL NDEA MONEY?

Have you enriched your science courses? As you are aware, Federal support is available to you under Title III NDEA. Now you can equip your science department in the way you have always wanted.

Cenco representatives have made a study of the Title III program and are qualified to give details in your area—how you may apply for your share. Write us today—no obligation.

To assist you further, the Cenco conversion list provides numbers which correspond to items in the "Purchase Guide"*. Send for PG-1 and for our suggestive list of apparatus. Specify elementary science, earth science, physics, chemistry or biology.



Serving education since 1889.

CENTRAL SCIENTIFIC CO.

A Subsidiary of Cenco Instruments Corporation

1718-0 Irving Park Road • Chicago 13, Illinois

Branches and Warehouses—Mountainside, N. J. Boston • Birmingham • Santa Clara • Los Angeles • Tulsa Houston • Toronto • Montreal • Vancouver • Ottawa

*Prepared by the Council of Chief State School Officers



Again congratulations to you and your staff for the excellence of the new dress, arrangement, and interesting contents of Volume 27, No. 1 (February issue) of *The Science Teacher*.

It isn't difficult to visualize the lift which any devoted teacher of science gets from seeing this professional journal, and the increasing confidence and enthusiasm in the job which results from the help which comes each month.

You're doing a great job for science!

PAUL E. KLOPSTEG, *Chairman
Board of Directors
American Association for
the Advancement of Science*

Congratulations on the new and more functional format of *The Science Teacher*. I was intrigued—and pleased—with the explanation of the reasons for the change. I had always wondered why such changes are made. This one is a good one.

SISTER MARY MARTINETTE, B.V.M.
*Mundelein College
Chicago, Illinois*

I have been very pleased with my first year of a sustaining membership. *The Science Teacher* is looked forward to more than any other periodical, and the recently added *Science World*, which carries *Tomorrow's Scientists*, is eagerly read.

C. R. JONGEDYK
*3158 North Salina
Wichita, Kansas*

EDITOR'S NOTE: The above letters are representative of the many which have been sent to us following the distribution of the February issue in its newly revised form. We confess to a pleasant glow of satisfaction in reading these letters, and we accept them on behalf of our Magazine Advisory Board, the contributors to TST, and the artist and production representative of our printer who works closely with our staff and guides us in producing our journal.

In addition to these letters, we welcome and invite your comments reporting critical analysis and positive suggestions for further improvement of future issues.

Now that I have read the first issue of the 1960 volume of *The Science Teacher* with a new format, I thought I'd let you know how disappointed I am. The cut-up job of previous issues was bad enough but with all the reading matter cut up with advertisements, it is detestable. Of course, I know that ads and not subscriptions pay for the publication.

Maybe I have "missed the point," as one usually says, but referring to the article "First Aid or Safety First," it certainly did not show technique. On page 550-1 of the December 1959 issue of *The Science Teacher* I find safety and technique faults. On page 550, the student removing the beaker from the tripod, not ring stand, could have been using *beaker tongs* for safety. This is the positive approach. On page 551, the picture on the left agreed that careless filtering is taking place but not incomplete filtering necessarily, perhaps loss of filtrate, yes? On the right, maybe careful filtering is taking place, but the technique could have been proper. On the bottom of the page both pictures show how the tubing and especially the glass could penetrate the aprons if heat is too great. It may be exaggerated but the student could suffer stomach wounds. I think the article in question was poor in explaining safety. The two pictures on the top of page 551 add nothing to safety but do to poor techniques.

Incidentally, I still think that NSTA members should only vote for their own Regional Directors and not for those in other regions.

ANDREW A. SHEROCKMAN
*5231 Wolfe Drive
Pittsburgh, Pennsylvania*

EDITOR'S NOTE: The article referred to above was included as a feature article to stimulate safety habits and was not intended to prescribe techniques. It was based, as indicated, on suggestions from the author and his experiences in the laboratory.

NEA NOTES

EDITOR'S NOTE: From time to time, we will report events and data of interest from other NEA departments in this column. Additional information on the items reported may be obtained by writing the individual departments.

Legislation Division of NEA

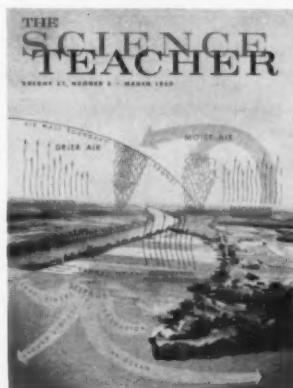
The House of Representatives is expected to begin debate this month on a moderate-sized school construction bill which friends of education hope to amend to include federal funds for teachers' salaries. The construction-only measure would authorize appropriations of \$325 million for each of fiscal years 1961, 1962, and 1963. The Senate on February 4 passed by a vote of 51 to 34 a \$1.8 billion bill which provides federal funds for school construction and teachers' salaries over a two-year period. This marked the first time in history that favorable Congressional action has been taken on legislation providing money for both salaries and construction.

Department of Rural Education

The Department of Rural Education will soon publish the book, *Children of Migratory Agricultural Workers*, by Elizabeth Sutton, Florida State University, based on three years of experience in a supervisory project in Palm Beach County, Florida, and North Hampton County, Virginia. The project was begun under the chairmanship of Howard A. Dawson, NEA Director of Rural Service.

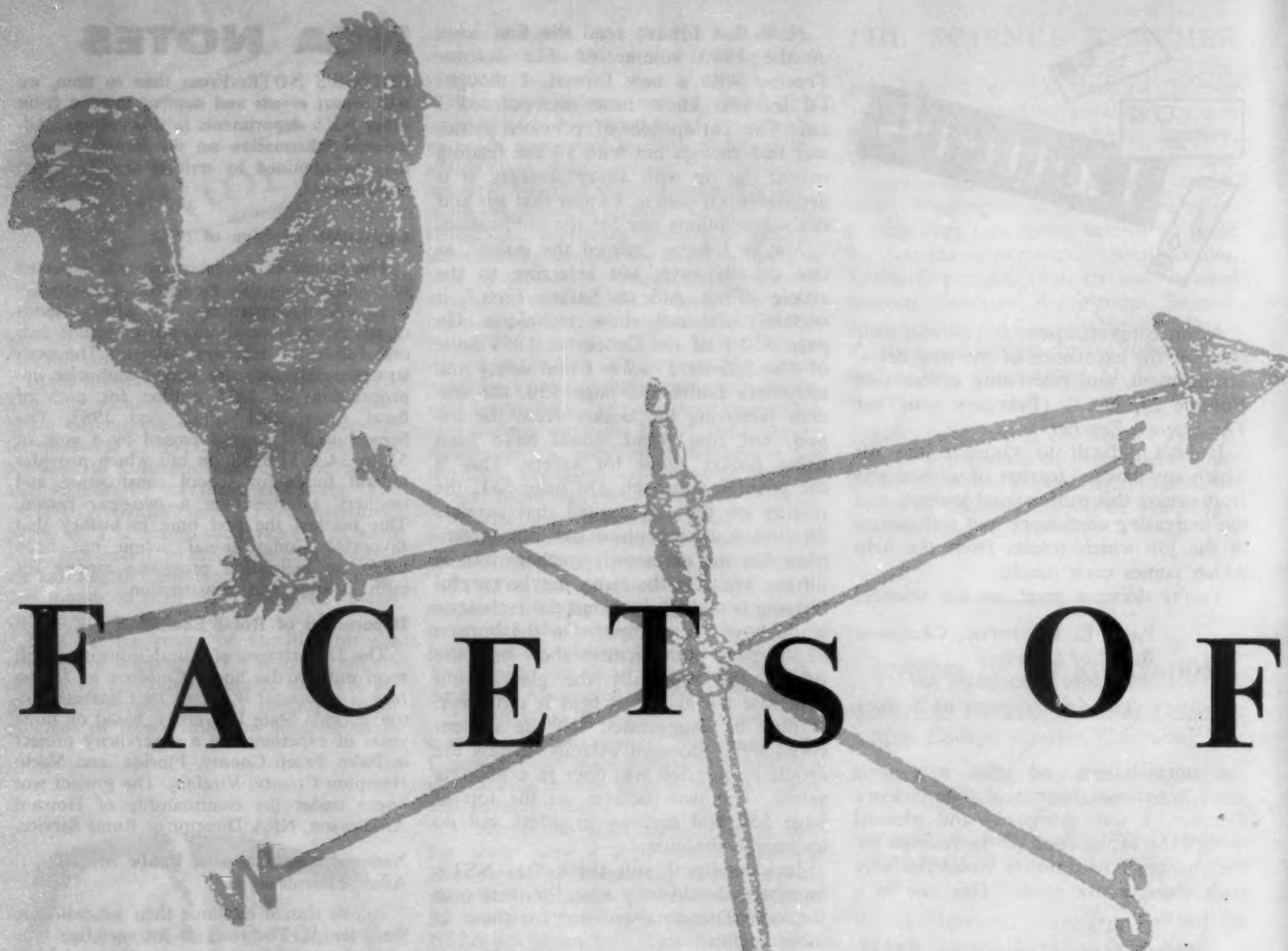
National Association of Public School Adult Educators

Adults should continue their education in the sciences. The rewards for spending time and energy to do this may well range from learning interesting information to finding a new career. To help adults to continue their education in science, the Association is planning a special curriculum publication tentatively entitled, "What Adults Can Learn in the Science Areas." The publication will be designed to aid public school adult educators develop science education programs suitable to the myriad interests and needs of adults.



THIS MONTH'S COVER . . .

THE HYDROLOGIC CYCLE—The transport of moisture by evaporation from oceans and other bodies of water, soil, and vegetation into the atmosphere . . . to condense into clouds and precipitation, and thus return to the land and waters in a never-ending cycle.



FACETS OF

By H. E. LANDSBERG

Director, Office of Climatology, U. S. Weather Bureau, Washington, D.C.

CLIMATE is part of our environment. It is an entity abstracted from the ever-changing weather. With topography and natural resources it is a basic element of our surroundings. Climate governs the flora and exercises a profound influence on the fauna. It rules the water supplies, determines our clothing, housing and, even to some extent, our health.

Long before the time of written history, man had been concerned with climate. His struggles with daily life and his migrations reflected the importance of this factor. Crude attempts at measurements antedate the present era. The Greek philosophers were well aware of the fact that climatic conditions had a relation to solar elevation above the horizon. That the inclination of the sun's rays with the horizontal

influenced the temperature was well known to them. It gave rise to the name "climata" (or inclinations). The steeper an angle the sun's rays make with the surface of the earth, the higher are the temperatures. The greater their slant, the cooler it gets. Thus, the geographic latitude becomes a main cause for climatic differences.

We can demonstrate this very easily by observing the temperature of a flat surface on a calm, sunny day. This temperature follows the solar elevation above the horizon. We can also readily see that slopes to the south get warmer than slopes toward the north. Just as we can note the diurnal pattern, it is also easy to follow the annual course of temperature. This difference between summer and winter is again following the changing elevation of the sun. But

here it becomes almost immediately obvious that other causes enter into shaping the march of temperature. The highest and lowest values do not any more coincide with the extremes of solar elevation. Instead they lag behind. This lag is a function of many factors but one of them is the influence of the oceans. At places far inland, the lag is short. At the coast or on islands it is long.

The distribution of land and sea on the earth exercises a very profound influence on the climate. The sun, by heating the earth near the equator more than at the poles, sets up the energy differences responsible for the general atmospheric circulation. But water masses and solid earth react differently to the heat transactions. Because of mobility a thicker layer of water gets involved than in the case of solid earth. In fact, the annual variation penetrates ten times deeper into the water than into the soil. This solid layer

CLIMATE

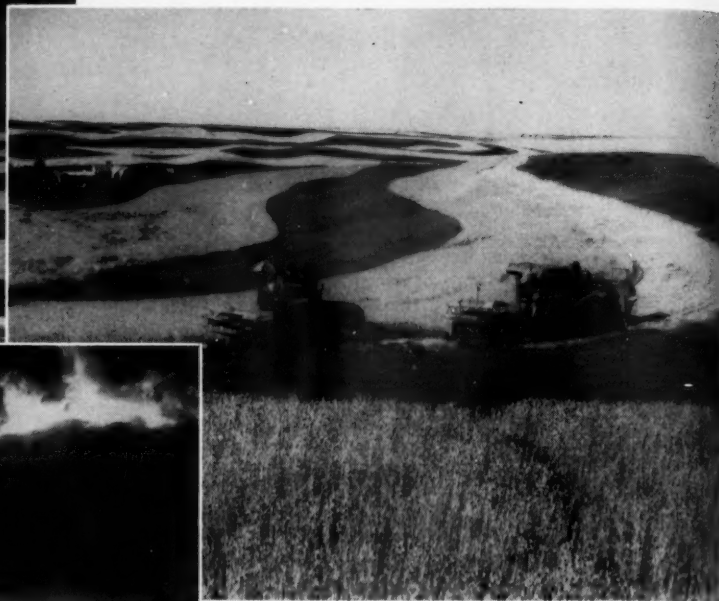
heats quickly and cools quickly. The large water masses take longer to heat and act as a reservoir of heat in summer and as a sink in winter. In contrast, oceans furnish heat to the air in winter, but are relatively cool surfaces in summer. This again causes important regular variations in the general circulation. On an extended scale this is seen in the monsoons which blow from land to sea in winter and then from sea to land in the summer.

These large-scale phenomena can now be studied and, to some extent, be duplicated in the laboratory. If one heats the fluid in a slowly rotating dishpan with a heat source at the rim and cools it in the center, a circulation analogous to that in the earth's atmosphere is set up—easterly flow near the rim (= equator), westerly flow with eddies in the middle zone (= moderate latitudes), and easterlies again near the center (= pole). Dr. Dave Fultz of The University of Chicago has performed an excellent series of experiments showing

Cumulonimbus clouds as seen from the air.

U. S. WEATHER BUREAU, BUTLER





PHOTOS BY SOIL CONSERVATION SERVICE,
U. S. DEPARTMENT OF AGRICULTURE

Weather records are indispensable for studies of local and regional climate in areas dependent on agricultural activities.

these effects. One can also duplicate the disturbances created in the flow of an obstacle (= mountain).

These experiments help us in a better understanding of the great variety of climates. In their world distribution these climates are an outgrowth of the general circulation. If the earth's surface were uniform and smooth, climatic conditions would be simple and readily predictable. The problems arise from the infinite mosaic of landscape and distribution of water surfaces. These often create notable climatic variations within a climatic zone. These small-scale patterns, often called microclimates, can be studied everywhere. They reflect such distinctions as the differences of night-time temperatures between a city and its suburbs, or a valley and a hill. On an even smaller scale one can note them within a garden, around a hedge, or between the north and south side of a house. Sometimes they are well reflected in the type of flowers that will grow or the dates on which they will start blooming.

But climate is more than temperature. It includes the many elements which make up the day-to-day weather. Hence precipitation, atmospheric pres-

sure, wind direction and speed, cloudiness, and special events such as thunderstorms are part of the climate. In weather studies and weather forecasting we treat these factors individually in a day-to-day fashion at many places simultaneously. In contrast, climatology

deals with them as statistical collectives. The difference is analogous to research in medicine which deals primarily with the well-being of individuals and public health or insurance studies which deal with disease incidence in a large population. Just as the

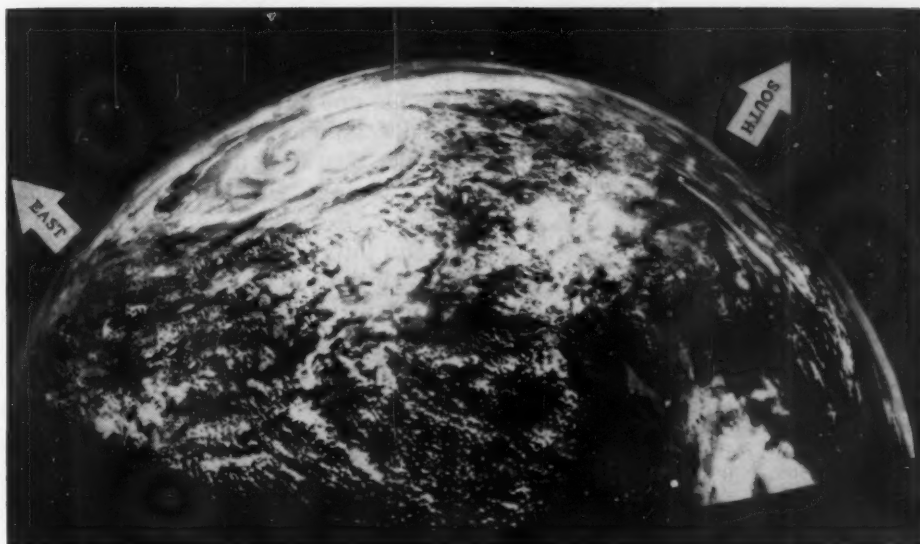
Typical thermometer shelter used at weather stations. Observer here performs a calibration of the radiosonde package which is sent aloft with a balloon to measure upper air conditions.

U. S. WEATHER BUREAU



individual health problems influence the disease patterns of a community so do the multitude of weather events determine the climate.

For this reason all studies of climate start with individual observations of the various weather elements. Most of these observations can be made with simple instruments. Many of them, such as rain gauges and wind vanes, are easy "do-it-yourself" projects. The main requirement is steady attention to these elements each day of the year, for a considerable period if one wants to establish the climate of a place. Fortunately, it is a proud tradition in the United States to take these records. Interest in them has been lively since colonial days. No less a person than Thomas Jefferson kept a weather diary for decades. Today, volunteer cooperative observers of the U. S. Weather Bureau keep such records in about 12,000 communities. Their unheralded labors are the indispensable basis for studies of local and regional climate. The data from these climatic stations are most helpful for answering many practical questions. Among them are: What crops will profitably grow? How large a heating plant is needed for a building? Will there be enough rain to keep local water reservoirs adequately supplied for a growing community? Industry, when building a new plant,



U. S. NAVY PHOTOGRAPH

Visible hurricane formation (Hazel), about 1000 miles in diameter, covers more than a million square miles. This is equal to about two-fifths of the area of the United States. The horizon extends almost 3000 miles from Oklahoma to Mexico. Photograph taken by Aerobee rocket over Texas and the Southwest. Fired from White Sands, New Mexico. (Upper left of earth photo shows hurricane spiral pattern.)

will consult climatic records to see if atmospheric conditions are conducive to accumulation of pollution products. Structural engineers want to know about maximum winds in an area to build safe towers and bridges. Most branches of engineering require background information of climatic conditions. This is particularly true if they are engaged in dam or road construc-

tion, layout of runways, transmission of power, radio propagation, or transportation. In commerce, marketing and advertising rely heavily on climatic information. As an example think of anti-freeze: Supplies of it should be in the hands of distributors prior to the first freeze in autumn. As it takes weeks to transport this from the factories to all parts of the country the day-to-day

Lightning during Thunderstorm.

U. S. WEATHER BUREAU



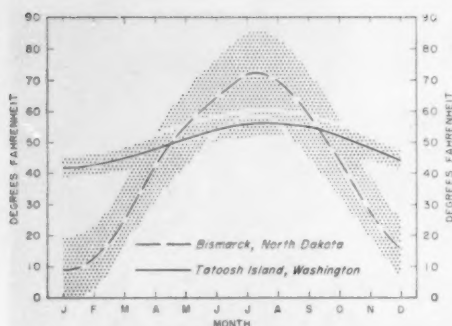


FIGURE 1. Mean annual temperature curves for a location in a maritime climate (Tatoosh Island) and one in a continental climate (Bismarck). The shaded zone indicates the average daily temperature range. Note that both annual and daily swing are much larger in mid-continent than at the coast.

forecasts of weather, which at best anticipate a five-day period, cannot help. Therefore, as best estimate the probable date, at a certain level of risk, is arrived at from the past record of this event. Similarly, for snow tires and chains the date of the first substantial snowfall can be estimated. In spring, the mean date of the last freeze is a good climatic guide for the planters of home gardens.

Compilation and analysis of the climatic data from 12,000 stations is a formidable task. Many of them have decades of daily observations, a few even as much as a century. Fortunately modern data processing systems have come to the aid of the climatologist. All current observations for over a decade and many of the earlier data have been placed on punched cards. Electronic machines permit the rapid calculation of means, standard deviations, and

other statistical elements of the frequency distributions. Specialized problems in climatology have led to the use and development of new statistical techniques. Sometimes knowledge of the distribution of extreme values is important. Other times, the probability of exceeding a given threshold is useful information. In this connection, not all these statistics refer to the surface layer of the air. For the planning of jet air routes it is pertinent to know how often winds exceeded given values and from what directions they came in various layers high up in the atmosphere. Such data help in the compilation of wind-aid and -retard tables. The basic observations for these analyses come from free balloons tracked by radar to great heights.

The availability of the data in a form permitting their processing by machine has opened an enormous store of scientific information. Some intriguing new avenues of research will be detailed later. But even the punched card is not an unmixed blessing. It becomes bulky in quantity. At the National Weather Records Center in Asheville, North Carolina, which is the archives for all of the country's climatic data, 350 million cards have accumulated. The growth rate is well over 70,000 per day. These include many cards from upper air observations, from hourly readings at regular Weather Bureau offices, and from many foreign countries. New devices microfilm the cards and the film is used as a storage medium. It will eventually serve directly as an input medium into elec-

tronic computers, which will perform various statistical analyses.

In many of the applications of climatic data we use records in lieu of a long-range forecast. They serve usefully if we don't need to know when an event is going to take place. For example, it is immaterial to the operation of a heating plant in a building on what days of the year the temperature is going to be below zero, as long as we know that such days are going to happen, say, between five and ten times each year. We can then see to it that the heater has the capacity to handle the load. Similarly, if we construct a tower with a probable life expectancy of fifty years, we want to be sure that the probability is low to have wind speeds exceeding the strength of the structure within that period.

But as in any other physical science, we like to think about the possibilities of predicting future events. The oldest method in climatology has been to follow the lead of astronomy and search for cycles. Two such cycles are very prominent: One is 24 hours long, the other 365 days. These correspond to the axial rotation of the earth and the revolution around the sun. Not even these, however, show very precise repetitions in climatological data. Although there is a good chance to have the lowest temperature of the day about an hour before sunrise and the highest two hours after noon, there are many days on which these two events take place hours before or after these times. In the annual course of events, the coldest month of the year in the moderate latitudes of the Northern Hemisphere is usually January but a few times February, December, or even March may play that role. Similarly in summer, we can never be positive whether July or August will turn out to be warmer. In rainfall, some areas have pronounced dry and wet seasons but nowhere do these occur with clock-like precision.

Nonetheless the search for cyclical events has been carried on with determination by climatologists. It has been a very frustrating hunt. Perhaps we are—as it happens often in science—following the wrong trail. Yet one would expect some elements of regularity in a thermodynamic system operating within fixed geographic boundaries and dimensions. With long series of data on punched cards, new attempts

Dust Storm

U. S. WEATHER BUREAU



Average Date of Last 32° Temperature in Spring

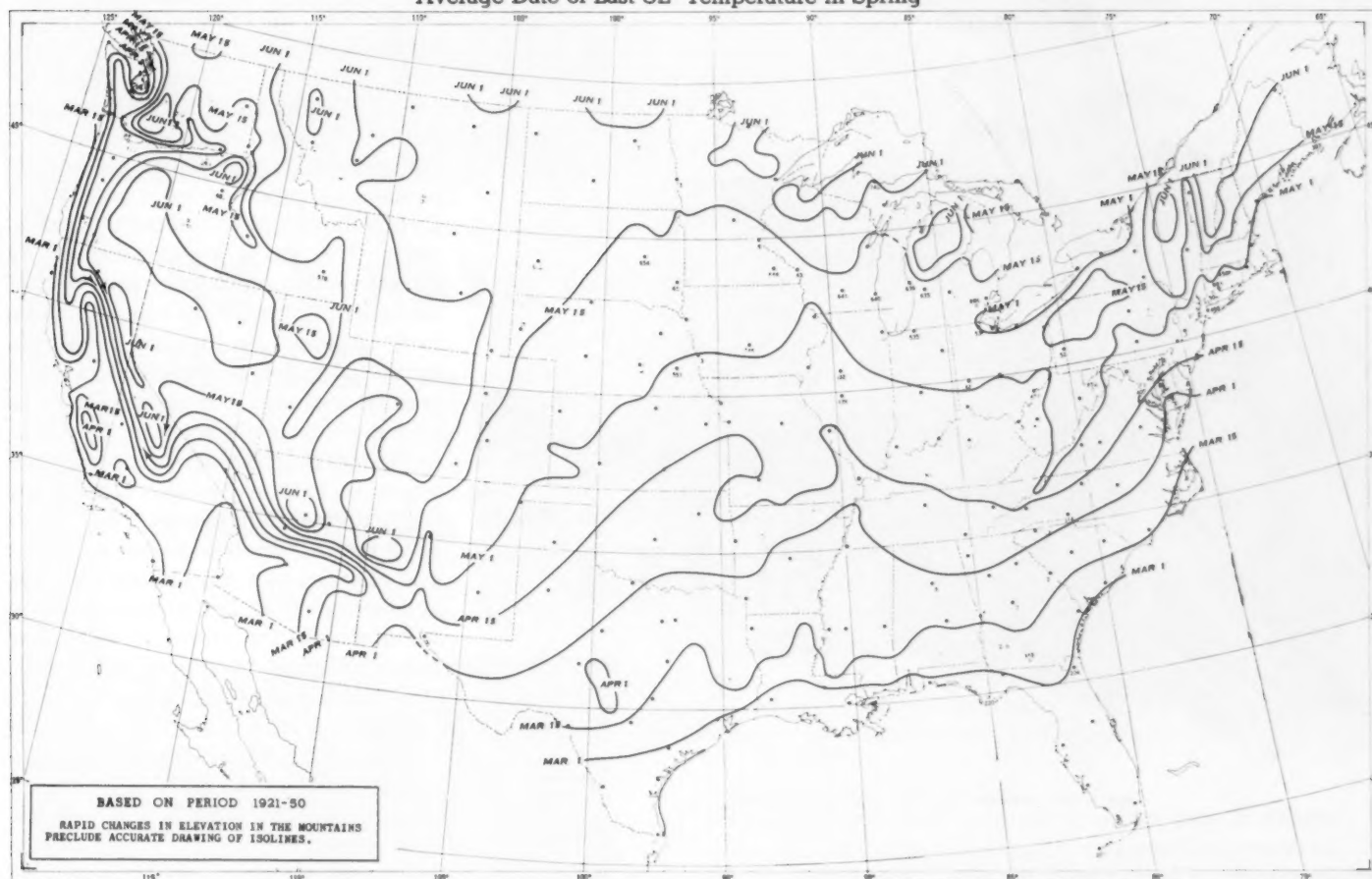


FIGURE 2. Average date of last daily minimum temperature at 32° F in spring. This chart can serve as a planting guide.

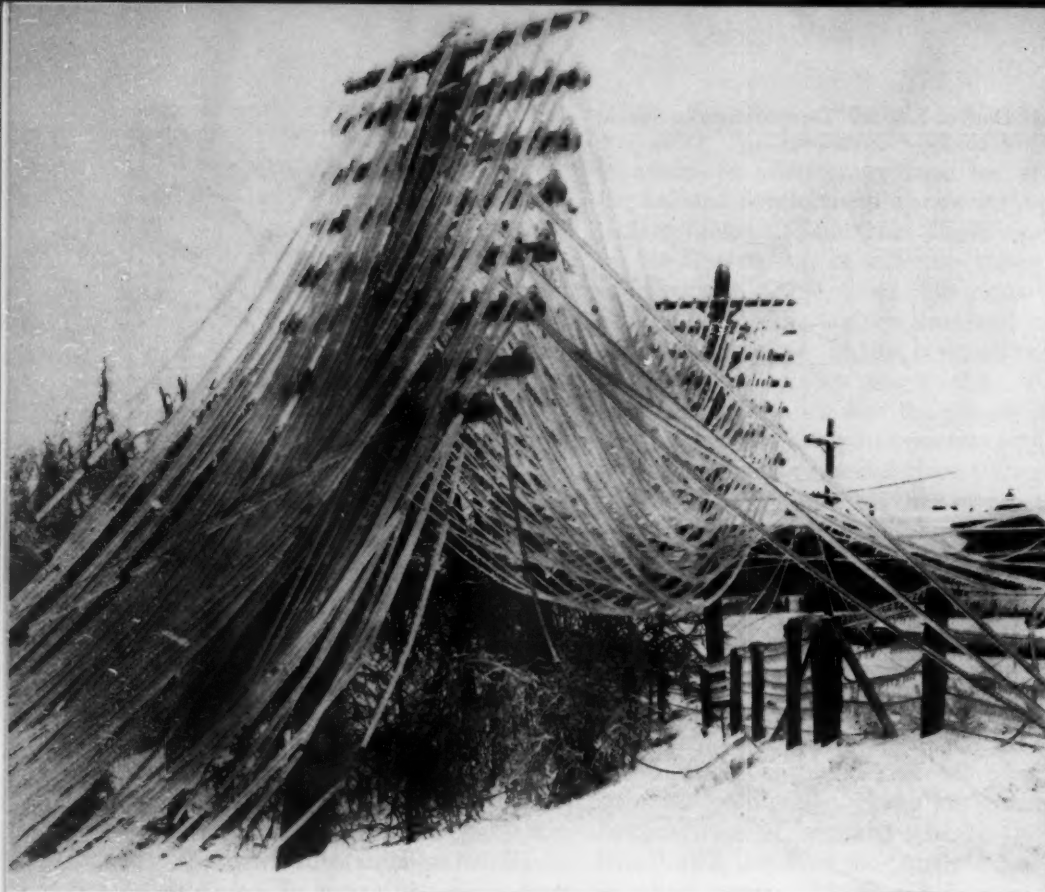
have been made to find hidden periodicities—hidden because they are certainly not immediately obvious. Powerful statistical methods that were originally developed in World War II to find sounds from submerged submarines in the welter of oceanic noise have found use in this problem. It is the procedure of power spectrum analysis, which is a form of generalized harmonic analysis. This indicates what general rhythms are contained in a time series of data. If we take some of our longer climatic records in our regions and subject them to this treatment a few facts emerge. One is that there is a slight tendency for repetitiousness in the interval from 5 to 7 days, and another around 12 to 20 days. These are not too pronounced but they seem to be real. The shorter period is probably connected with long waves in the westerly winds which dominate the moderate latitudes. These are probably somewhat analogous to standing waves of fluid dynamics in a closed system. Usually there are 3 to 5 such waves

around the hemisphere. They are migrating around the earth so that each locality gets under the influence of one every few days. Occasionally, these waves show some precision and for a month or so we may have the experience that it will rain always on the same day of the week. Then the rhythm may disappear and another one take its place. How they change and why they change is still a puzzle. The longer cycle of around two weeks has something to do with the meridional exchange of energy between lower and higher latitudes. This too takes place in a pulsating form but the length of the rhythm is irregular and changes in the pulse rate are not yet within our predictive grasp.

If we look at longer time intervals about the same picture emerges from the analysis. In this area, much has been said and written about the climatic influence of varying solar conditions. These are often expressed in terms of sunspots. These manifestations of solar activity themselves are irreg-

ular. On an average the length of one cycle is 11 years but it can vary from 8 to 18 years. There is ample evidence for solar influences on terrestrial atmospheric events, especially in the ionosphere but as we come close to the surface the relations become very tenuous. The power spectrum analysis of data in the eastern United States shows a slight rhythm around 11 years. It accounts for less than 5 per cent of the over-all variability of temperature.

The closest connections to solar influences have always been noted in the tropics and for elements which integrate conditions over large areas. Among these are lake levels and river flows. If we arrange, for example, the river discharge of the Nile River according to sunspots over the period of eight cycles one can note that there is some variation within the cycle with a tendency for low discharges the year before sunspot minimum. Again less than 20 per cent of the variability is accounted for by the possible rhythmical contribution of the sunspot variation. With-



Ice storm damage resembles ribboned shreds.

U. S. WEATHER BUREAU

out knowledge of what causes the sunspots we can predict their changes only by statistical methods. Thus there is presently little chance of using this only partially predictable element to presage a terrestrial condition, which seems to follow these sunspots to a very limited degree. In spite of this lack of success the fascination of the problem remains.

We are equally puzzled by climatic fluctuations of still longer duration. These are measured in decades, centuries, and millenia. At one time climatologists deemed climate to be essentially invariant, at least over the span of a human life. The records we have accumulated definitely show that this is not so. There are slow secular trends. Over the past fifty years, for example, there has been a gradual warming over the globe. It is not uniform. In the Arctic it has been more pronounced than in moderate latitudes or in the southern hemisphere. In the eastern United States it is 1 or 2 degrees Fahrenheit. The winters, in particular, have become warmer. In the Arctic the warming has led to a gradual melting of the ice. Some scientists have even visualized a complete melting of the polar ice caps. Until we know what causes the warming process, this is only

speculation. In fact, there is no assurance that the warming trend will continue. Of course, geological evidence shows that the whole earth has had a warmer climate for epochs counted in hundreds of millions of years. We also know that there have been ice ages. The last major glaciation showed a number of stages of advancing and retreating ice sheets. In North America, the latest continental glacier formation began to recede 11,000 years ago. So the question is: Are we now in an interglacial stage or are we slipping completely out of the ice age? Until the effects can be traced back to their causes, this question cannot be answered unequivocally. Some scientists believe that terrestrial phenomena are responsible for the large-scale climatic changes—possibly the formation of mountains and volcanic eruptions. Others think that astronomical conditions cause the changes—among them fluctuations in path elements of the earth's orbit, axial wobble, cosmic dust clouds between sun and earth, and possible changes in the output of solar energy and related phenomena.

For the latest fluctuations there are some arguments that man and his activities has had an influence. In the last

century this was a claim made for deforestation and cultivation. No proof for large-scale changes can be given although local changes can be attributed to these activities. Over the last few decades, however, another element has entered. Through various man-made combustion processes large amounts of carbon dioxide have entered the atmosphere. This gas is a good absorber of infrared radiation. It intercepts part of the outgoing long-wave radiation from earth to space. An increase of this gas in the atmosphere would lead to a gradual warming. The period for which we have sufficiently accurate air analyses is too short to be sure of this increase in carbon dioxide. During the International Geophysical Year 1957-1958 the carbon dioxide concentration was checked at a world-wide network of stations. It is hoped that this will continue into the future so that close surveillance can be kept of this important constituent of the atmosphere.

Many sciences can point with pride to the solid doctrines that have been built. Questions have been answered and discoveries leading to better understanding have been made. In climatology, as in other phases of atmospheric science, many puzzles still remain. There are more questions than answers. These stay as a challenge to human imagination. Here is a vast domain still to be conquered and the scientists of tomorrow will find all the adventures of exploration waiting for them.

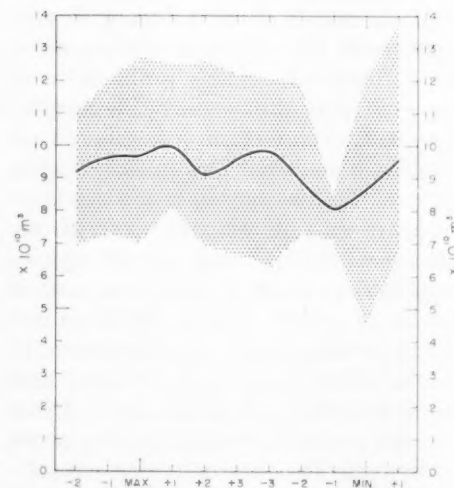
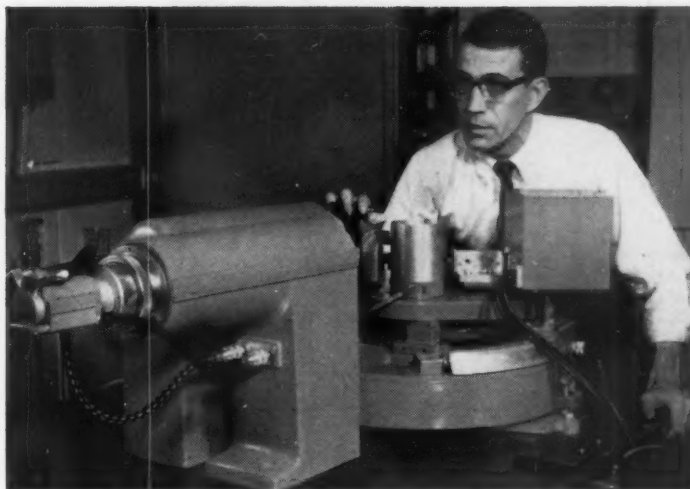


FIGURE 3. Curve shows the average annual discharge (in 10 billions of cubic meters) of the Nile River during the past 8 sunspot cycles. The years within the cycle are indicated as abscissas. The shaded area around the curve shows how widely the river discharges have varied in individual years from the mean value.



HE X-RAYS WOOD...

to help make
telephone poles
last longer



Chemist Jack Wright developed the use of this X-ray fluorescence machine for testing the concentration of preservatives in wood. Here he bombards a boring from a test telephone pole with X-rays.

This Bell Labs chemist is using a fast, new technique for measuring the concentration of fungus-killing preservative in telephone poles.

A boring from a test pole is bombarded with X-rays. The preservative—pentachlorophenol—converts some of the incoming X-rays to new ones of different and characteristic wave length. These new rays are isolated and sent into a radiation counter which registers their intensity. The intensity in turn reveals the concentration of preservative.

Bell Laboratories chemists must test thousands of wood specimens annually in their research to make telephone poles last longer. Seeking a faster test, they explored the possibility of X-ray fluorescence—a technique developed originally for metallurgy. For the first time, this technique was applied to wood. Result: A wood specimen check in just two minutes—at least 15 times faster than before possible with the conventional microchemical analysis.

Bell Labs scientists must remain alert to *all* ways of improving telephone service. They must create radically new technology or improve what already exists. Here, they devised a way to speed research in one of telephony's oldest and most important arts—that of wood preservation.

Nature still grows the best telephone poles. There are over 21 million wooden poles in the Bell System. They require no painting, scraping or cleaning; can be nailed, drilled, cut, sawed and climbed like no other material. Scientific wood preservation cuts telephone costs, conserves valuable timber acres.



BELL TELEPHONE LABORATORIES

World Center of Communications Research and Development



Newton had his falling apple

In scientific achievement, chance sometimes plays a role but the teaching of science always requires predictable results . . . reliable tools . . . stimulating aids. Clay-Adams educational materials leave little to chance.

Clay-Adams offers a large selection of science equipment — for laboratory and classroom — including many items for your equipment programs under Title III of the National Defense Education Act. The Clay-Adams line is the result of more than 40 years' experience in the perfection of scientific teaching material. Each of its products — there are more than 1000 — bears the stamp of authenticity and durability. Those for use in the secondary school are detailed in the Clay-Adams "Buyer's Guide for Science Teaching," already mailed to all science departments. Check the Guide — to facilitate your purchases under Title III. Use it — to order quality materials designed to provoke greater student experience, expanded laboratory experimentation — for gratifying science instruction.

In Science Teaching...
Trusted Tools for
Learning and Doing

Clay-Adams

New York 10, N. Y.

FOR a college chemistry teacher to offer suggestions to a group of high school science teachers about teaching the high school chemistry course may seem presumptive. It is similar to the Monday quarterback who advises the football coach how he *should* have played last Saturday's game. I have not taught a high school course, but I have taught hundreds of college freshmen their first course in chemistry, and many more hundreds their first college course in the subject immediately following their high school course. Furthermore, I have done considerable work with high school teachers. Finally, I have been teaching chemistry for a long enough time to have seen the field grow in depth and complexity, year after year, until now a major revolution in organization and curriculum content is long overdue and sorely needed.

While this article will deal mainly with problems of the teaching of beginning chemistry, the same type of difficulties characterize other elementary science courses. Two kinds of difficulties which confront the chemistry teacher may be referred to as (1) general or background, and (2) the specific conceptual difficulty. Background difficulties must be recognized and considered in planning the teaching program; they can be resolved effectively and automatically by the competent teacher. Specific conceptual difficulties may be alleviated through appropriate methods of handling troublesome course topics through appropriate introductory material and definitions.

By background difficulties we mean those attitudes and prejudices toward the study of chemistry which are held by a significant number of students before they first set foot in the classroom. What can a chemistry teacher do to overcome student fear, prejudice, lack of motivation, lack of self-confidence, deficient preparation, weak orientation?

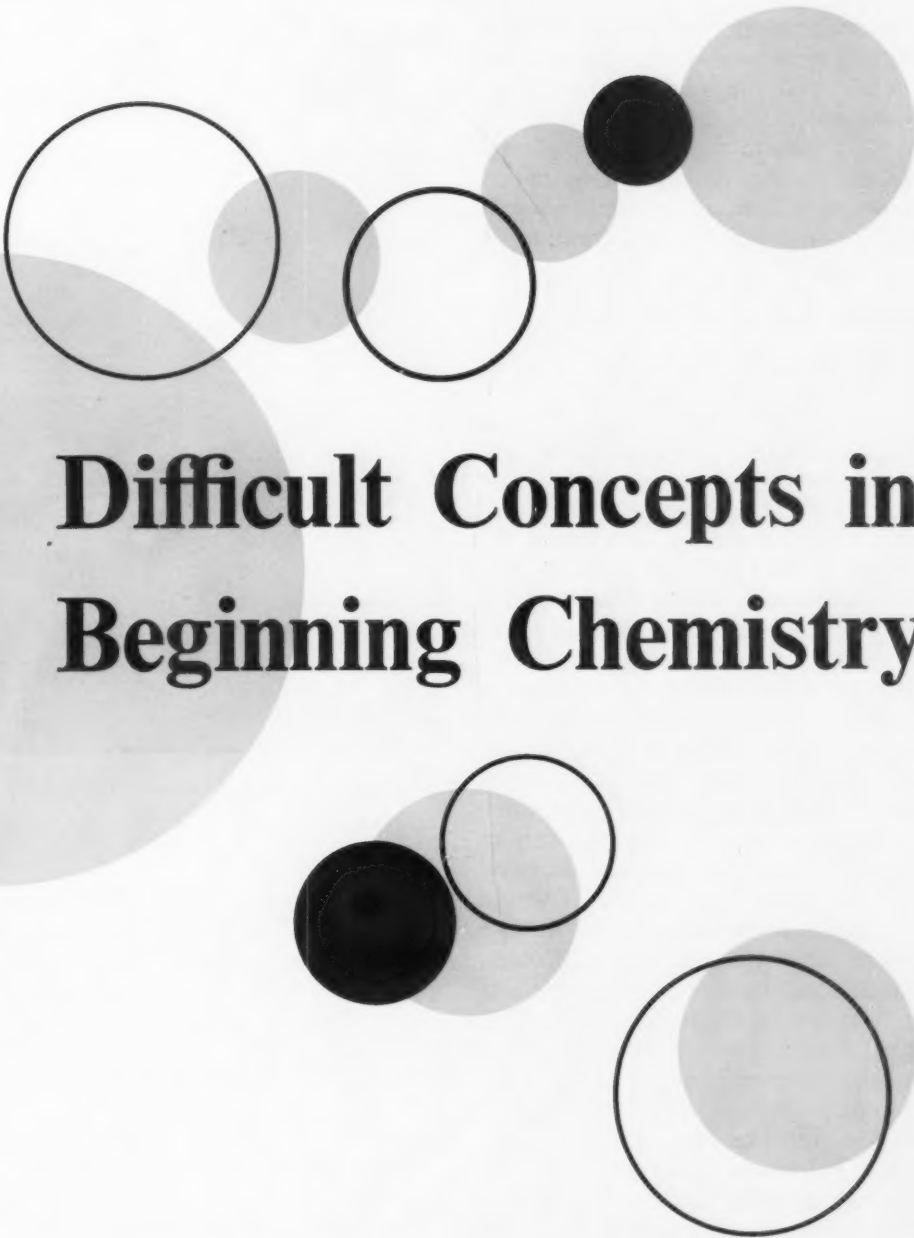
Primarily, the teacher himself must be well trained in chemistry and must possess an adequate understanding of the relationship of chemistry and chemists to other fields. If he has no confidence in his own knowledge, he can scarcely instill a confident attitude in his students. Secondly, the teacher, with full recognition of the objectives of his course, must give careful thought and planning to all phases of the instructional process. In so doing, he

must be aware of the necessity for proper orientation of beginning students to their new study, and make certain that these students are not lost or discouraged in the early stages of the course.

The chemistry student is learning not only the rudiments of a science, but at the same time, a large new vocabulary of "foreign" words and terms. As a chemistry teacher, you must consciously introduce terminology to your students in dosages and in a manner which they can follow with understand-

ing. This is not easy. Each technical term must be introduced meaningfully; it must be used over and over again in the same manner; and the students themselves must use it until it becomes an integral part of their language.

In connection with language difficulties, consider the matter of definitions. Students are often inclined to believe that the best definition is always the ready-made one in the textbook, or the one given by the teacher. Instead of employing memorization, students should be encouraged—perhaps com-



Difficult Concepts in Beginning Chemistry

By GRANT W. SMITH

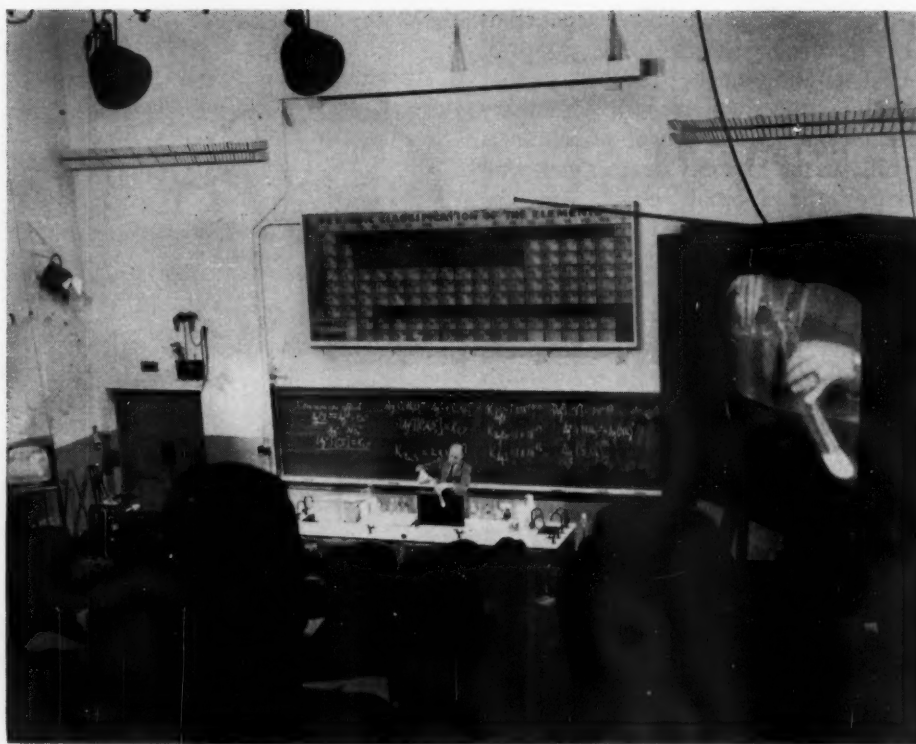
Director of General Chemistry, The Pennsylvania State University, University Park, Pennsylvania

pelled—to express definitions and concepts in their own words. It is most important that the student has a clear understanding of the subject regardless of his ability to express it in the most elegant manner possible. If he understands it, he can use it, while his self-expression can be improved with training and practice.

Specific Conceptual Difficulties

To visualize that which is optically invisible is a difficult process for the novice chemist. If he is consistently unsuccessful in his attempts to understand the concepts and materials he is studying, his interest becomes passive, and he is likely to give up. As a result, the chemistry teacher is compelled to plan the presentation of his subject by (1) omitting all materials not serving a useful purpose, and (2) presenting all relevant materials as systematically as possible. A basis for decision might be these questions: Is this material helpful in achieving a clear understanding of the basic concepts essential to an introductory course? Or is it more likely to confuse and complicate the learning process? Using these criteria, I would certainly exclude the general acid-base theory, activity and activity coefficient, calculations of chemical equilibria, and the concept of the hydrogen bond, to name a few. I would include as pertinent, interesting materials, suitable examples which tie the study of chemistry in with everyday living and personal experiences. This type of material offers much of the "spice" of the course and leads to a better understanding of the more abstract concepts. The principles of combustion apply not only to hydrogen and oxygen, but to the operation of the Bunsen burner, the campfire, the furnace at home, and even to the oxidation of "fuels" in the body of the student.

The second principle for guiding the teaching of introductory chemistry is that material should be presented systematically, not as isolated facts. So far as possible, topics should be related to one another and to basic principles as the branches and twigs of a tree are related to the trunk. As the fundamental unifying concept, i.e., the trunk of the tree, I believe the structure of matter is the most logical one at the present time. The most direct and accurate interpretation of behavior of substances and the best understanding



Author demonstrates material to chemistry class through use of closed-circuit television.

of chemical principles are obtained in terms of modern concepts of atomic and molecular structure. The historical approach is too often a back-door approach. Historical material is of importance and interest for the understanding of the development of science and as a part of one's education and culture, but it is usually an illogical and rather inefficient way to study modern chemistry.

For illustration, consider the following question: Are the "laws of chemical combination" best understood when presented by the historical approach, or by recognizing them as mere corollaries of atomic theory? One can describe the experiments which over many years led to the statements of these principles; or one can devise and carry out experiments to demonstrate them to his own satisfaction. They still remain unexplained empirical relationships until we introduce the idea of the atomic theory. By the use of simple models representing two or three kinds of atoms, we can easily and conclusively show that the principles of Definite Composition, Multiple Proportions, and Combining Weights are simple results which follow automatically in this process once we accept the principle of atoms.

Introduce the unifying concepts of atomic and molecular structure and theory early in the course. Use only that amount of detail required to give a clear, but simple picture of our physical world composed of fundamental particles from which all atoms, molecules, and ions are formed. From this basic concept, once it is clearly understood in its simpler aspects, the other concepts of chemistry can be readily drawn and interpreted as the course develops. Among others, these include "laws" of chemical combination, periodic classification and relations, oxidation and reduction, chemical bonding, kinetic-molecular theory, nature of chemical reactions, equilibrium, and nuclear reactions. I do not propose treating these subjects beyond their simpler aspects in the introductory course. In more advanced courses, however, a similar systematic treatment will continue logically and successfully for the student with this background.

Let us look at some important specific areas of difficulty inherent in the teaching of chemistry. Knowledge of the behavior of gases is of great importance to the chemist or physicist. It is also important for purposes of a liberal education, for many common phenomena, such as combustion, respi-

for educational laboratory furniture...



WOOD IS BEST



KEMTECH

KEWAUNEE TECHNICAL FURNITURE CO., STATESVILLE, NORTH CAROLINA

KEMCO

KEWAUNEE MANUFACTURING CO., ADRIAN, MICHIGAN

5 BIG REASONS

WHY WOOD IS PREFERRED FOR SCHOOL LABORATORY FURNITURE

LONG LIFE

Kewaunee's case history files reveal many 40-50 year old installations still giving satisfactory service.

Selected Oak, finished to Kewaunee-Technical's exacting, high quality standards, provides the most durable school laboratory furniture it is practical to build.

LOW COST MAINTENANCE

Reliable studies show that genuine Oak laboratory furniture, properly finished, requires practically no maintenance. In case of damage, the wood can be easily refinished on-the-spot.

ATTRACTIVE APPEARANCE

No one can deny the unsurpassed warmth and beauty of wood finished by expert craftsmen. Oak especially offers a wide selection of grain effects and harmonizing colors to match any decorative scheme.

PLEASANT ENVIRONMENT

Faculty and students both feel "at home" with wood. Its natural aesthetic value is unmatched by any other material. Wood is both inviting and pleasant to look at and to touch.

REQUIRED QUIETNESS

Drawers and doors of wood furniture operate quietly. There's no distracting clatter.



**OVER THE YEARS... WOOD CONSTRUCTION PROVES
TO BE THE BEST POSSIBLE INVESTMENT**

Read these Typical Statements from Leading Educators*

"When the old science building at this college was built about 1910, it was fitted up entirely with 'Kewaunee' furniture. After forty years, much of this furniture is still in good condition; and some of the original tables are still being used in some of the Physics, Geology and Biology laboratories."

"About 1926, we purchased four Kewaunee student center tables. After 20 years service, they were

moved in 1946 to some Army Surplus barracks which we then used for laboratories. We recently moved these desks a second time into our new building and have somewhat regretfully covered up the Oak grain with an alkyd enamel. As our enrollment grows, we expect them to serve another generation or so of students. They are still very respectable looking and completely serviceable."

"Wooden tables which I know have been in use, in our chemical laboratories, for as long as 50 years have been refinished several times and they appear to be good for another 50 years."

**Names on request*

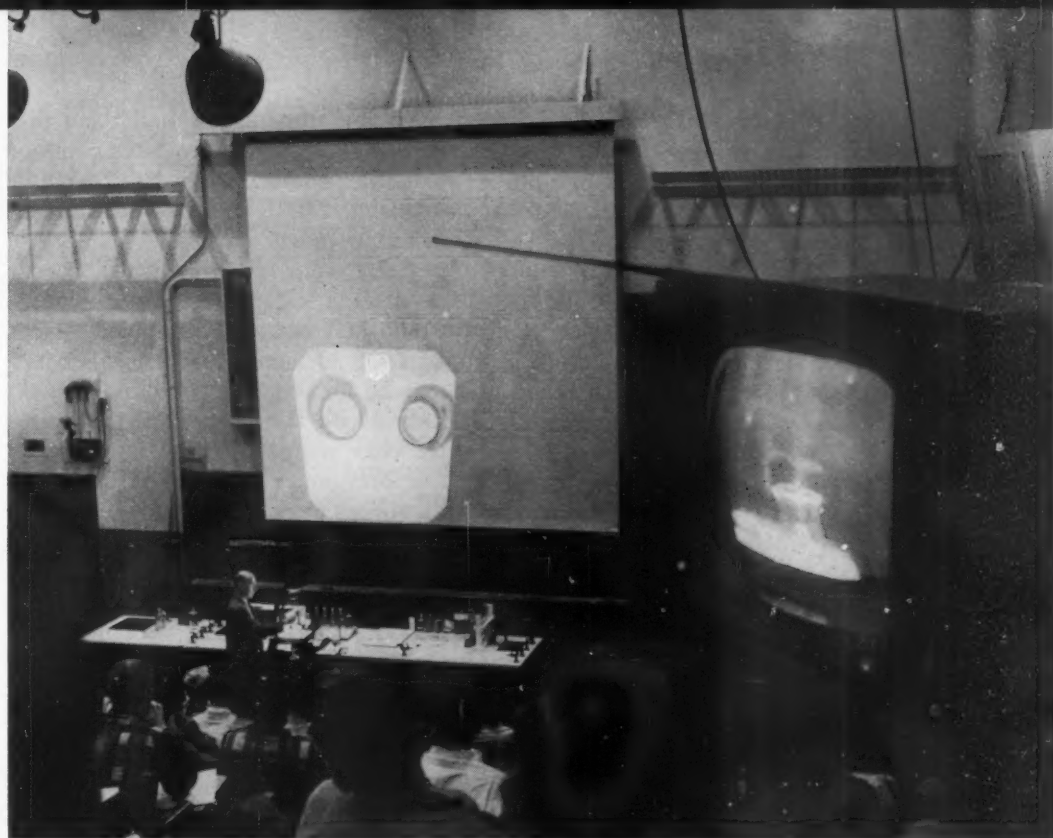
KEWAUNEE TECHNICAL FURNITURE COMPANY
STATESVILLE, NORTH CAROLINA
AFFILIATED WITH KEWAUNEE MFG. CO., ADRIAN, MICH.

ration, plant synthesis, etc., involve the gaseous state. Lack of knowledge of gases and their manipulation was a very strong retarding factor in the early development of science. Until simple principles of gaseous behavior were discovered by Galileo, Torricelli, Boyle, Charles, Priestley, Lavoisier, and others, gases were mysterious, confusing, contrary-appearing stumbling blocks to experimental progress. Once understood, scientific progress was rapidly accelerated.

It is common practice to introduce students to the subject of gases with the assumption that they already know what a gas is. Bear in mind that we are asking the student to become acquainted with materials he usually cannot *see*, cannot *touch*, cannot *hold*, cannot associate with definite *shape*, characteristic *size*, or any of the other criteria with which he is accustomed to associate familiar objects.

Before the student is ready to understand behavior of gases (gas laws), he must first know what a gas is. This knowledge should be imparted slowly in a series of well-planned experiences and thought developments leading to familiarity with these elusive substances. Consider the following suggested exercises and demonstrations:

1. Start with solids and liquids which are more familiar and show relations to the gaseous state. Ice melts to water; water boils and becomes a gas; the gas condenses to water, a liquid. Iodine melts and sublimates; the vapor (gas) is visible (other colored gases—bromine, chlorine, nitrogen dioxide).
2. Demonstrate the presence of the atmosphere around us. Blow on fingers to "feel" it. Show how a sheet of paper "glides" through the air when dropped. Blow up a toy balloon (recall the pumping of air into a tire). Evacuate a gallon varnish can to show pressure of atmosphere.
3. Demonstrate diffusion phenomena by introducing some liquid bromine into an evacuated vessel. Repeat, using a similar vessel containing air at ordinary pressure.
4. Demonstrate thermal expansion of gases by cautiously heating a stoppered can and blowing out the stopper.
5. Demonstrate "barometer tube" of mercury. Try to make a similar barometer tube using water. Explain these phenomena in terms of



Overhead projector is used simultaneously with closed-circuit television which gives direct view of reaction in experiment.

the pressure of the atmosphere supporting the column of liquid. Compare with soda straw syphon. (Do not use the term "suction" in discussing these phenomena.)

6. Show how gases can be trapped and manipulated. Demonstrate collection of gases by upward and downward displacement of air, and over water. Show or describe measurement of gases by weight and by volume (pressure and temperature controlled).

With a planned campaign of demonstrations and experiences, the student will subconsciously acquire an understanding of the nature of gases. He now has the basis for learning the quantitative aspect of the behavior of gases. Throughout all of this, the kinetic molecular picture of gases should be instilled into his mental imagery. He should think of gaseous pressure and temperature in terms of molecules moving almost without restriction in space. The motion of these particles results in the effects we term pressure and temperature.

Matter should be portrayed from the structural viewpoint, in terms of electrons, protons, and neutrons. If a simple, clear atomic structural concept is acquired early in the course, the

foundation for much basic chemistry is laid. By employing models, diagrams and suitable demonstrations, the picture of the atom as a structure composed of a dense nucleus associated with a definite system of electrons may be readily conveyed to students' minds. It is very difficult to teach atoms and molecules without using models, for the concepts of the nature of matter are highly abstract, even though logical.

Once a student has grasped a simple picture of the atom, he has acquired a basic, but very useful method for understanding periodicity of properties, and hence, the periodic classification of elements. While the introductory course in high school cannot pursue the relationship between periodic system and structure in too great detail, the student is now in a position to understand one of the most useful, interesting, and important simplifying classifications in the scientific field. He can now appreciate the importance of the octet or inert gas structure in the world of chemical reaction. He can now understand the best available simple basis for classifying metals and non-metals. He can now picture the formation of chemical bonds between atoms, since, by use of models or simple drawings, the sharing or transfer of

valence electrons may be graphically portrayed and understood.

Care must be exercised in all of these portrayals to avoid oversimplification which leads to implanting of false ideas: e.g., carbon atoms are little black balls; or electrons sit like little dots on a circle around a black center; or atoms are two-dimensional. It should be clear to all that models and diagrams are at best but a crude, simplified representation of something which we cannot describe completely even in complex mathematical symbolism. The extent to which the teacher treats these structural concepts and related principles of chemical bonding and periodic classification depends upon his estimate of the capacities and scientific interests of his students, as well as the course objectives.

"Valence" is a term which is rapidly and quite properly being abandoned because it has been used to represent too many things. As an adjective, it does seem to find proper use (valence electron, valence number, valence bond). The preferred term for expressing the oxidation state of an element or radical is "oxidation number." ("Valence number" is also acceptable.) The oxidation number may be positive, negative, or zero; it is properly applied to atoms, ions, or radicals; it may easily be assigned to atoms either electrovalently or covalently bonded. Stress the fact that oxidation numbers are based on certain arbitrarily assigned values for key elements. In this way they somewhat resemble atomic weight scales, temperature scales, electrode potentials, and many others. When we assign an oxidation number of +6 to sulfur in sulfate, we do not imply that the sulfur atom has been stripped of its six valence electrons nor that it has an actual charge of six positive units.

Writing Formulas

Simple formula writing becomes almost automatic for one who has learned the oxidation numbers of common ions and radicals. This skill is easily acquired by even the least capable high school chemistry student. Without correct formulas, it is impossible to write equations, work problems involving formulas, or to appreciate the quantitative nature of chemistry. To impress students with the importance of writing correct formulas, I have often resorted to a simple teaching device. I have

given the students, or had them prepare, a list of the elements and common oxidation numbers considered essential—about 15-20 cations or positive elements or radicals and 10-15 anions or negative elements or radicals. In each of several successive class periods I would take about five minutes to read a list of 20 names of chemicals which may be formed by combinations of the radicals on the master list, while the students write the 20 corresponding formulas on a ruled strip of paper with numbered lines. Papers may be quickly graded in class by the students or outside by the teacher. Each day, the formulas most frequently missed the previous day, together with new ones making up a list of 20 are given in the same way. As soon as most students are achieving nearly 100 per cent on these short quizzes, the device is abandoned. This method should not be used too early in the year, but only after sufficient background has been obtained so that the significance and use of formula writing can be appreciated.

Balancing equations is a related operation which must be understood by the beginning student. Balancing of simple equations is usually learned readily by students. I seriously question the advisability of teaching special devices for balancing the more complex oxidation-reduction equations in the high school course. Students who have been taught a certain method in their high school course are often strongly prejudiced against learning any other method. Special devices should be omitted, except perhaps in advanced courses with exceptional students.

What about the phenomenon of oxidation-reduction itself? The basic principles of this process should be taught in the high school course because of their great importance; life itself depends upon such processes. It would seem the best way to proceed might be to reserve the presentation of oxidation-reduction until the students have a sufficient background of factual and theoretical knowledge so that the concept can be presented in its general form, i.e., in terms of gain or loss of electrons, or change in oxidation state. Special cases will then become normal examples of general behavior, and confusion of terminology will not be present. The following phenomena may well be included in an oxidation-reduction presentation: (1) reactions of metals and



Student works with balance in laboratory used for freshman chemistry studies.

nonmetals with oxygen; (2) reduction of certain oxides by hydrogen; (3) reduction of hydrogen ion in acidic solution by active metals; (4) action of oxidizing acids, such as nitric acid, on copper and similar metals; and (5) simple oxidation and reduction reactions in electrolysis. Without complicating matters these phenomena can all be made meaningful in terms of the general concept of oxidation and reduction for high school courses.

One of the most difficult concepts to teach in general college chemistry is that of chemical equilibrium. In many years of teaching the course, I have not yet found nor heard of anyone who has found the ideal way to put this concept over effectively. Mathematical formulations are involved in a more advanced treatment, but the high school course does not generally treat equilibrium quantitatively. High school courses do involve understanding the nature of a dynamic equilibrium system and should include qualitative predictions of change produced by variations in pressure, temperature, and concentration (Le Chatelier's Principle). If a clear and accurate conceptual picture of a system at chemical equilibrium is achieved by the student, then Le Chatelier's Principle can be truly understood by the student, and does not become a mere memorized combination of words and phrases. The teacher can feel justifiable pride in these results.

Analogies, diagrams, and animated cartoons all fall short of giving an accurate picture of the system at equilibrium, yet some can be quite helpful. One trouble with the analogies often used is that they show the forward and reverse reactions occurring between two separate regions, and attempt to show migration from one region to the other. I used one like the following for years. Two groups of men are placed on opposite sides of a line. If the same number of men per second move across the line in one direction as move per second in the opposite direction, the numbers of men in the two groups do

not change, i.e., the system is at equilibrium. This is truly a type of equilibrium, but it is not a good analogy to leave in a student's mind as a representation of chemical equilibrium. Its usefulness, if any, would be in the preliminary discussion in which the meaning of the general term "equilibrium" is explained.

Most analogies and diagrams have the same gross fault: "reactants" and "products" are spatially separated into two distinct regions. The chemical equilibrium equation gives the same false picture because of the separation into "two sides of the equation:" $A + B$

$\rightleftharpoons C + D$. No wonder the student soon talks in terms of the two sides of the reaction! Students should be reminded that since "products" and "reactants" in a chemical system at equilibrium are completely and hopelessly mixed, it is impossible to change temperature, or pressure, or anything else for the reactants without doing the same to the products.

A better analogy, but still an imperfect one, is that proposed by W. E. Caldwell in 1932, the "dance floor analogy." One thousand couples appear on the dance floor wearing white and one thousand appear in black. They begin dancing. Originally, the couples are of two types (reactants), M_wL_w (men and ladies in white) and M_bL_b (men and ladies in black). When they collide, they exchange partners: $M_bL_b + M_wL_w \rightleftharpoons M_bL_w + M_wL_b$. Eventually equilibrium will be reached; in this case, when all four concentrations are equal.

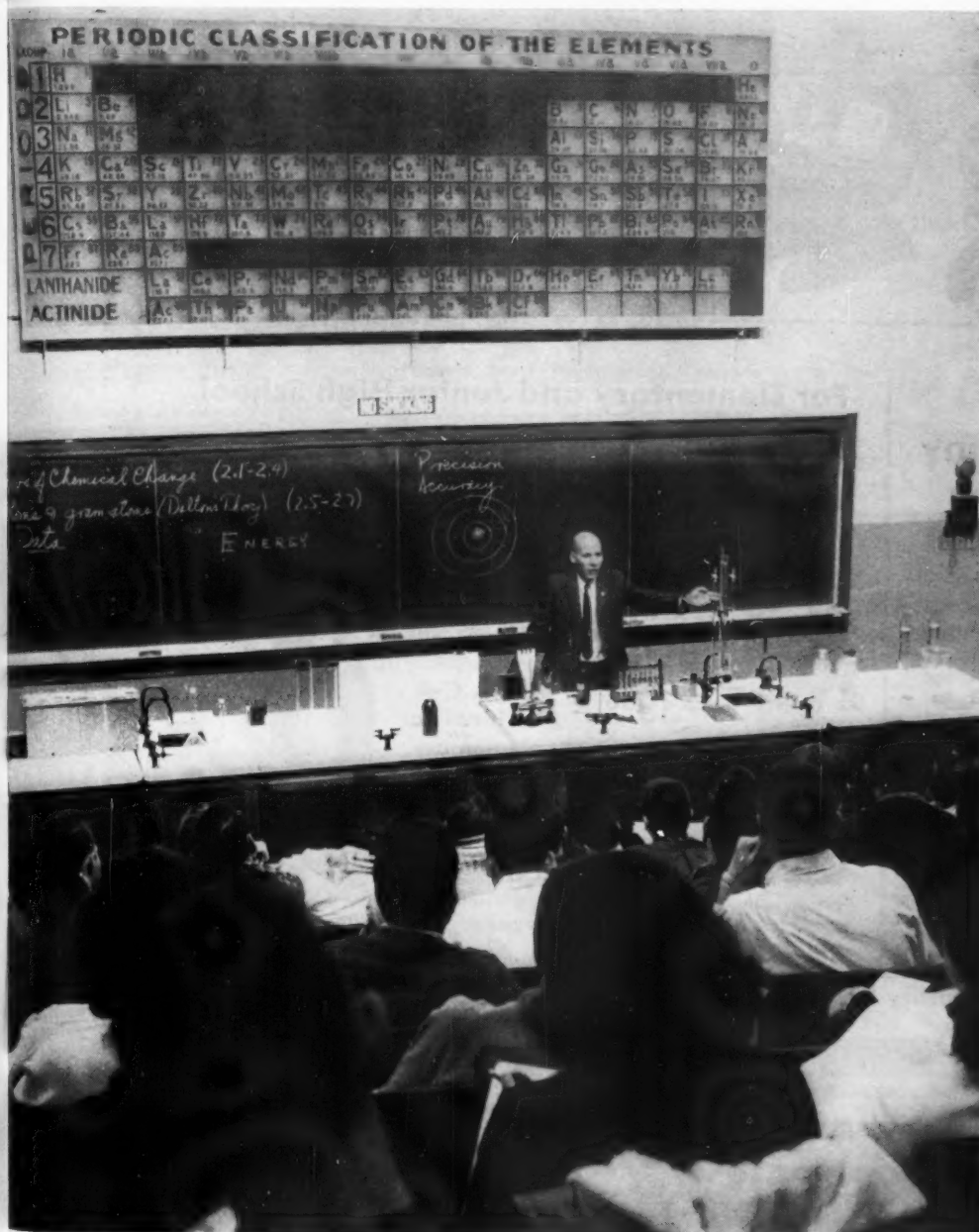
Various changes in conditions can be introduced which will effect the equilibrium conditions, or speed of reaching equilibrium.

1. If "hot" or fast music is played by the orchestra, collisions will be more frequent and equilibrium will be reached more quickly (effect of increase in temperature on rate of reaction, or effect of catalyst, in this case the orchestra).
2. If we impose the condition that "dark gentlemen prefer blondes," then all M_bL_w couples stroll into the garden one by one, and the reaction, in effect, proceeds to completion as in the reversible chemical system in which one of the products is effectively removed from the system as a gas or precipitate.

Other interesting analogies can be drawn by changing the condition of the example, yet at best it is still a very imperfect analogy.

It is quite impossible to discover the one "best" way to teach any particular concept in chemistry. What is best for one teacher may not be best for another. There are, however, certain problem areas of instruction in beginning chemistry which can be identified readily. Every teacher must carefully plan his presentation, and then continually observe the progress and reactions of his students to make sure that he is planting correct ideas in their chemical understanding.

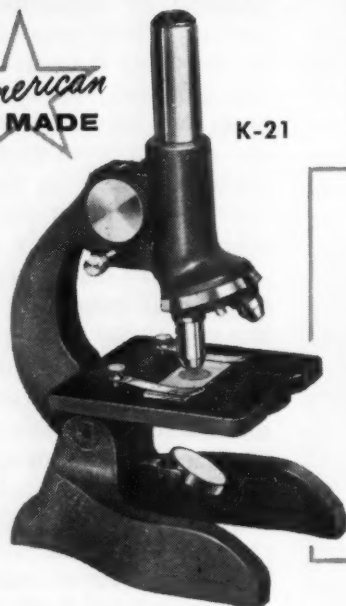
Author lectures to beginning chemistry class interpreting definitions and relating uses of equipment to experiments described.





TESTA MICROSCOPES are designed and priced to provide the greatest number of quality instruments for a given budget!

American
MADE

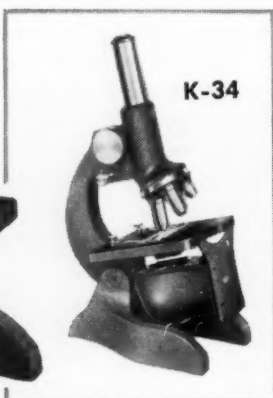


K-21

For High School and College

Testa "Model K" Microscopes have many special features usually found only on much more expensive research instruments. 12x Huygenian eyepiece. Color-coded parfocal objectives. Extremely precise fine focus. Helical rack and pinion. Automatic adjustable safety stop. Large professional 90° tilting stand with bumper toes to protect stage and objectives.

MODEL K-21. Double revolving nosepiece. 10x and 45x parfocal color-coded objectives. 120x to 700x magnification. 6-aperture diaphragm disc. **\$9450**



K-34

MODEL K-34. Triple revolving nosepiece. 10x, 18x, and 45x parfocal color-coded objectives. 120x to 700x magnification. Includes illuminator, condenser, and iris diaphragm. **\$11600**

FOR NATURE STUDY

Study live insects and whole specimens with **WIDE-FIELD MODEL A**

No slides to prepare!

...with this rugged, full-size microscope. Features large working distance and 15x, 45x, and 75x magnification. Unusual versatility. 360° inclinable arm. Kellner-type eyepiece. Triple divisible objective. Large reversible black and white stage.



\$5485

For Elementary and Junior High School

Start their interest in Science early ... with the **TESTA S-3**

This sturdy, full-size instrument is ideal for beginners. It is equipped with the basic components of standard compound microscopes. 10x Huygenian eyepiece. 75x to 250x magnification. Double divisible color-coded objectives.



\$3985

TESTA G-4 ... ideal for elementary biology

Standard-size compound microscope provides variable

magnification from 100x to 400x. Makes teaching easier ... students learn faster. Triple divisible color-coded objectives. 6-aperture diaphragm disc. 12x Huygenian eyepiece.

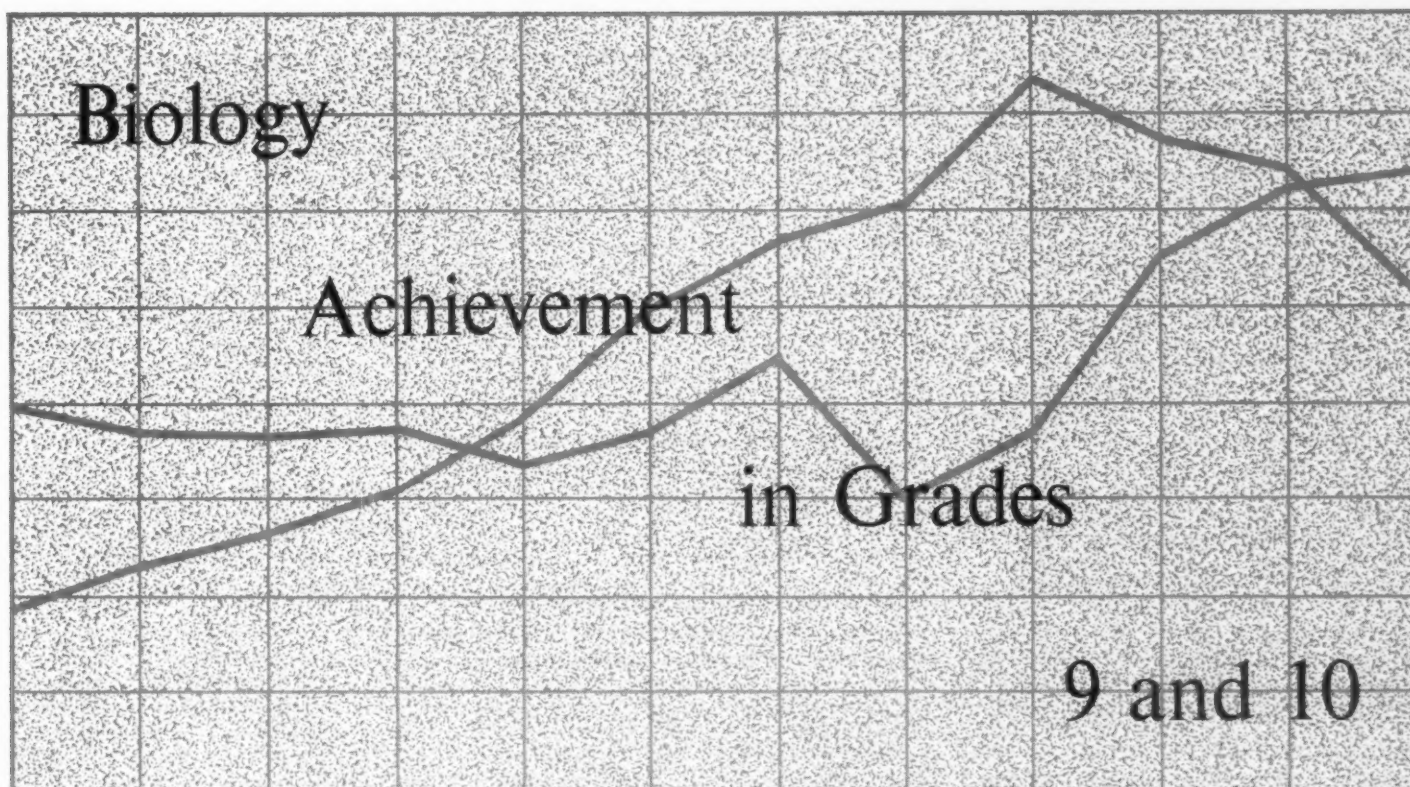


\$6450

Quantity Discounts to Schools

TESTA MFG. COMPANY
Dept. ST3—10126 East Rush Street—El Monte, California





Report of Test Scores in Biology by Students in the Denver Public Schools

By **GEORGE E. MATHES**

Director of Science, Denver Public Schools, Colorado

and **SAM BLANC**

Coordinator of Instruction, Denver Public Schools, Colorado

This report and the article following by L. H. Heidgerd represent two studies which yield conflicting evidence on the question: At what grade level should a course in general biology be placed?

ONE of the unsettled questions in science education has been the grade placement of general biology. Traditionally a senior high school course, some authorities have indicated that biology could be taught in junior high school to selected ninth-grade pupils. In order to validate this hypothesis, the Denver Public Schools offered a course in biology to selected pupils in grade nine in five junior high schools during the school year 1958-1959, and compared results with unselected high school pupils in grades ten, eleven, and twelve and with an equated group of tenth-grade pupils.

This report is therefore a summary of the pilot study.

Purpose of the Study

The purpose of the study was to compare the achievement of selected ninth-grade students with the achievement of high school students in general biology, as measured by a test of general biology developed by Denver science teachers.

Development of the Measuring Instrument

The test was developed by a committee of junior and senior high school

biology teachers. Content was based on the approved course of study in use in the Denver Public Schools. The questions sampled the student's understanding of factual information and certain laboratory experiences from each of the units included in general biology. The test consisted of two parts and took two class periods to administer. Part I consisted of ninety multiple-choice questions designed to measure the student's ability to recall certain facts, principles, and concepts. Part II consisted of forty multiple-choice questions designed to measure the student's ability to generalize from certain laboratory experiments. The test was administered to all second semester biology pupils in the junior and senior high schools near the end of the school year. The total number of pupils taking the test by grade level and sex is given in Table I.

Schools and Pupils Involved in The Study

The study involved most of the students taking biology in junior and senior high schools during the second semester of the 1958-1959 school year. The senior high school pupils in the

study were those who were enrolled in the standard biology course. The junior high school pupils were those who were completing the same course in grade nine. These ninth-grade biology students were selected on the basis of their interest in science and in science-related careers, their ability as measured by a standardized intelligence test, their grades in academic subjects, and the recommendations of their science and counseling teachers. The high ability of the ninth-grade group can be seen from the distribution of scores on the Otis Test of Mental Ability. Table II reports the range and interquartile scores.

Comparison of Selected Ninth Grade Pupils with Unselected High School Pupils

Since the test was given to practically all ninth-grade and high school pupils taking biology, it was possible to compare scores of the two groups. A comparison between the measures of central tendency and range indicated that the ninth-grade pupils did substantially better than the high school pupils. This was to be expected since ability was one of the factors in selection of the ninth-grade pupils. Table III compares the measures of central tendency and gives the range of the two groups.

Pursuing science avidly, ninth-grade girl student ranks high in ability and performance.



TABLE I
Number of Pupils Participating in the Study by Grade Level and Sex

GRADE LEVEL	BOYS	GIRLS	TOTAL
Junior High School, Grade 9	143	56	199
Senior High School, Grade 10	415	393	808
Senior High School, Grade 11 and 12	159	281	440
Total	717	730	1,447

Comparison between Equated Ninth and Tenth Grade Pupils on Parts I and II of the Test Matched Groups

An attempt was made to equate the ninth-grade pupils with an equal number of tenth-grade pupils and compare the scores made on the test. This was accomplished using all of the 199 ninth-grade group and selecting an equal number of boys and girls with almost identical IQ's from the group of tenth-grade test results. The ninth-grade Otis IQ score was used for both groups. The range and measure of central tendency for the two groups are given in Table IV. The two groups are so similar that for all practical purposes they may be said to have equal ability.

TABLE II

Range and Measures of Central Tendency for Pupils Taking Biology in Grade Nine as Measured by The Otis IQ Test (199 Pupils)

	BOYS	GIRLS	TOTAL GROUP
Q ₃	127.0	121.0	124.0
Median	119.0	115.3	118.5
Q ₁	112.4	112.0	112.3
Range	101-142	101-133	101-142

TABLE III

A Comparison Between Selected Ninth Grade Pupils and High School Pupils on Parts I and II of the Test (Perfect Score = 140)

	NINTH GRADE	HIGH SCHOOL
Q ₃	106.0	94.0
Median	97.5	82.5
Q ₁	87.5	70.0
Range	59-128	25-125

Part I of the Test

Studies of the two matched groups were made for boys and girls on Parts I and II of the test. One hundred forty-three boys and fifty-six girls participated in this phase of the study at both ninth- and tenth-grade levels. Part I of the test consisted of ninety questions. In general, boys did better than girls in both the ninth and tenth grade. The

TABLE IV

Range and Measures of Central Tendency between Ninth and Tenth Grade Pupils Matched on the Basis of Sex and Scores on The Otis Test of Mental Ability
(143 Boys — 56 Girls)

	NINTH GRADE		TENTH GRADE	
	BOYS	GIRLS	BOYS	GIRLS
Q ₃	127.0	121.0	125.3	121.0
Median	119.0	115.3	119.6	115.3
Q ₁	112.4	112.0	112.4	112.0
Range	101-142	101-133	101-138	101-133

TABLE V

A Comparison of Measures of Central Tendency and Range for Matched Groups of Ninth and Tenth Graders on Part I of the Test
(143 Boys — 56 Girls. Perfect Score — 90)

	NINTH GRADE			TENTH GRADE		
	BOYS	GIRLS	TOTAL	BOYS	GIRLS	TOTAL
Q ₃	71.7	66.0	70.8	69.7	65.4	67.2
Median	66.5	60.5	64.4	61.9	56.5	61.2
Q ₁	58.8	58.3	56.3	56.4	49.5	52.7
Range	42—89			41—85		

interquartile range for the ninth-grade group was 56.3 to 70.8 and for the tenth-grade group, 52.7 to 67.2. The range of scores is almost the same but the top scores for the ninth-grade group are higher than for the tenth-grade group. Likewise, the low scores in the tenth-grade group are below those for the ninth-grade group. This would in-

dicate that the ninth graders, in general, did better on Part I of the test than did their matched tenth-grade counterparts. Data are given in Table V.

Part II of the Test

Part II of the test consisted of forty questions. Again boys did slightly better than girls in both groups. The range of

FREE

RUSSIAN HIGH-SCHOOL SCIENCE EXAMINATIONS

Send for fascinating translation of actual Soviet tenth year final examinations in physics, chemistry, algebra, geometry. With it you get—also free—detailed guide for applying Title III funds (National Defense Education Act) to purchase of classroom science materials; plus illustrated catalog of tested, educator-approved science-teaching aids for all age groups, produced exclusively by



SCIENCE MATERIALS CENTER, Dept. M-109 | A Division of The Library of Science
59 FOURTH AVENUE, NEW YORK 3, N. Y.

A new dimension in teaching SCIENCE!



Hydroelectric Dam generates electricity from water power for fifteen separate experiments.

STUDENTS LEARN BETTER WORKING WITH NEW PRODUCT DESIGN MODELS

Five new models developed by educators and engineers demonstrate the scientific principles relating to SOIL, AIR, WATER, ELECTRICITY AND MAGNETISM in 60 dramatic student experiments. Hundreds of teachers report that they cover more subjects more effectively with less effort and preparation time. The models increase student interest, curiosity and comprehension.

EASY TO USE, inexpensively priced and built to last, models include full equipment, illustrated Teacher Manuals, student worksheets and portable case.

FEDERAL-AID, under the National Defense Education Act, now available for this equipment in most states.

SEND FOR FREE CATALOGUE and cost information, or a demonstration in your school without obligation.

SCIENCE EDUCATION DIVISION

product design co.

2796 Middlefield Rd., Redwood City, Cal.

MAIL COUPON TODAY

PRODUCT DESIGN CO.
2796 Middlefield Rd., Redwood City, Cal.

Please send data on Models for Teaching:

☐ Soil ☐ Air ☐ Water
☐ Electricity ☐ Magnetism

☐ Without obligation also demonstrate these models in our school.

Name.....Title.....

School.....

Address.....City.....

scores in the ninth-grade group was from 17 to 40 correct, and for the tenth-grade group from 19 to 40 correct. The median score for grade nine was 35.1 and grade ten 33.2. This may indicate that again ninth-grade pupils did slightly better on Part II of the test than tenth-grade pupils. The high scores made by both groups on Part II of the test may indicate that both groups learned how to generalize and apply the principles of biology equally well. Data for range and measures of central tendency for Part II of the test are given in Table VI.

Summary

On the basis of a study of the scores on the total test for the matched groups of ninth- and tenth-grade students, it would seem that selected ninth-grade pupils can achieve as well, and in some instances better, than tenth-grade pupils of comparable ability in general biology. In Part I of the test the differences among the three measures of central tendency used are probably large enough to have some statistical significance. In Part II the large number of

scores may indicate that the test was not difficult enough for the higher-ability pupils. Consequently, the difference between the two groups was not so great and may not be a significant difference.

Conclusions

This pilot study was established to test the assumption that selected ninth-grade students could do as well as tenth-grade students in a course in

general biology. The data reported here point out clearly that the group of ninth graders selected on the basis of ability, interest in science, and teachers' recommendations did considerably better than unselected high school students. When compared with a group of tenth-grade students selected to match the ability of the ninth grade, ninth-grade students did slightly better than the tenth-grade group. Boys did slightly better than girls in both groups.

TABLE VI

A Comparison of Measures of Central Tendency and Range for Matched Groups of Ninth and Tenth Graders on Part II of the Test (143 Boys — 56 Girls. Perfect Score — 50)

	NINTH GRADE			TENTH GRADE		
	BOYS	GIRLS	TOTAL	BOYS	GIRLS	TOTAL
Q ₃	37.3	35.6	36.1	37.1	34.9	35.7
Median	35.2	32.9	35.1	33.3	33.1	33.2
Q ₁	31.9	29.8	31.2	31.7	29.3	29.8
Range	17—40			19—40		

WESLEYAN UNIVERSITY

GRADUATE SUMMER SCHOOL FOR TEACHERS



CURRICULUM

ASTRONOMY

Descriptive Astronomy
Spherical and Practical
Astronomy

BIOLOGY

Introductory Biology
Evolution
Heredity
General Embryology
Physiological Mechanisms
Animal Histology

CHEMISTRY

Principles of Chemistry
Organic Chemistry
Chemical Equilibria
The Chemical Bond and
Molecular Structure
Thermochemistry and
Electrochemistry
Biochemistry

GEOLOGY

Earth Materials

MATHEMATICS

Mathematics Refresher
Course

Applied Algebra

Introduction to Vector

Algebra

Introduction to Probability
and Statistical Inference

Calculus

Topics in Modern Algebra

Topics in Geometry

Mathematical Analysis

Probability Theory

PHYSICS

Introduction to Physics

Electronics I

Atomic Physics

Wave Motion

PHILOSOPHY OF SCIENCE

The Nature of Scientific
Thought

plus courses in art, economics,
government, history, literature,
music, philosophy, psychology,
religion, and expressive writing.

The courses are designed especially for teachers, the classes are small (average enrollment: ten per section), the student is able to discuss, question, obtain individual attention.

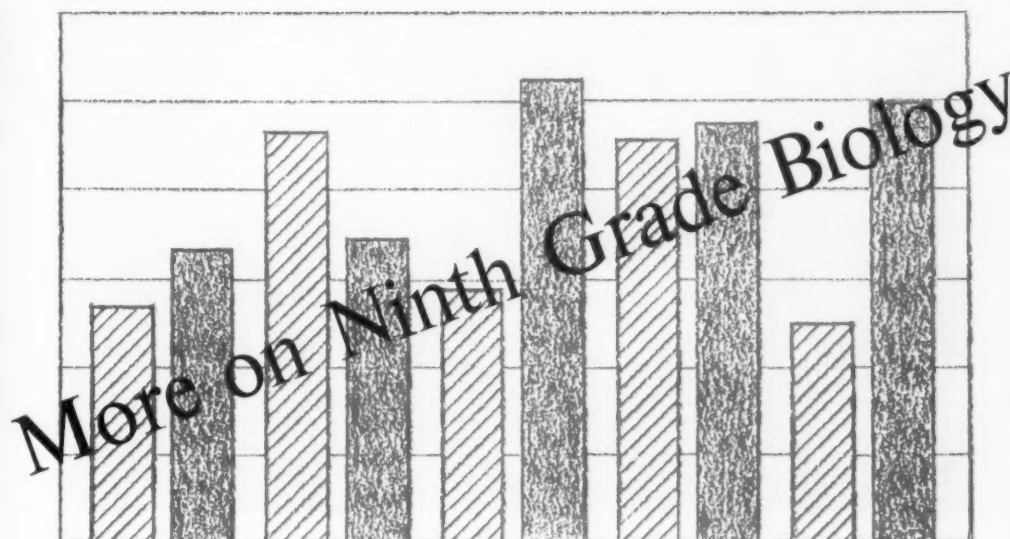
Students who wish to complete a coherent program for thirty hours of credit may become candidates for the degree of Master of Arts in Liberal Studies or for the Certificate of Advanced Study. Candidates and non-candidates are equally welcome.

CLASSES JULY 7-AUGUST 16, 1960

For further information please write to

SCIENCE MAJOR, SUMMER SCHOOL

Box 39 Wesleyan Station, Middletown, Conn.



Summary of a Doctoral Thesis completed at the University of Illinois

By LLOYD H. HEIDGERD

Associate Professor of Science, State University College of Education, Buffalo, New York

SHOULD required ninth-grade general science be eliminated and replaced with required ninth-grade biology? This is a question which is receiving some considerable attention. A number of reasons have been advanced for considering this move. Among them are: (1) Ninth-grade general science is often repetitious of upper elementary or early junior high school science; (2) Radio, television, and the wide distribution of popular science books and magazines have increased the general science knowledge of most youngsters; and consequently (3) Many youngsters are bored by the customary ninth-grade general science course; and (4) These are not times to waste effort in science education.

Arguing positively, it has been held that high school students would obtain a higher average level of science knowledge if ninth-grade biology were introduced, particularly if it were followed by a tenth-grade physical science course. A two-year general science sequence would be established without

the boring repetitions and consequent ineffectiveness of seventh- and eighth-grade general science in ninth-grade general science and the unnecessary duplication of the biology unit of ninth-grade general science in tenth-grade biology. This argument, of course, assumes that the present practice of the majority of students taking two years of science continues. According to government figures approximately 75 per cent of the U. S. tenth-grade population is enrolled in biology (1). Assuming now that tenth-grade physical science is offered, it can further be reasoned that weak science students would be either eliminated from taking physics or chemistry or better prepared for those courses by their experience in tenth-grade physical science. In effect, standards in chemistry and physics could be raised. Moreover, well-qualified students could be excused from the physical science course if they included chemistry and physics in their course plans. This would allow room for an advanced science or a course of

interest in another subject matter area.

The study which is summarized in the following paragraphs was an attempt to get data on some of these arguments. The approach used made practical an investigation possessing some notable differences from previous studies of the same or similar curriculum changes. Among these differences were: (1) More teachers were involved—four biology, three physical science, and three physics teachers; (2) The achievement of a relatively large number of students, over 425 in biology alone, was evaluated; and (3) Total school populations were included.

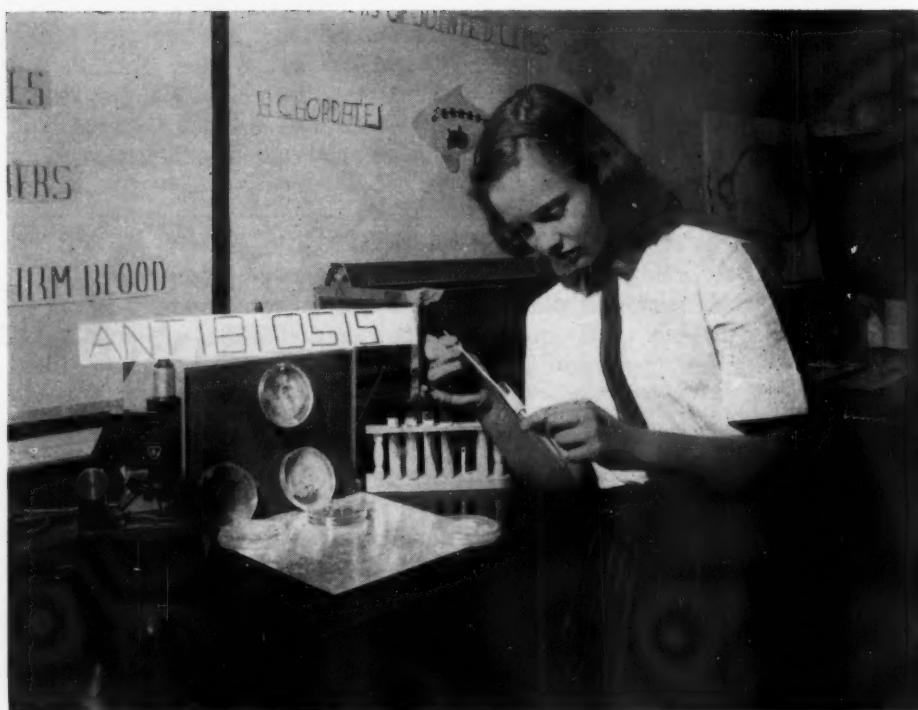
Suitable measuring instruments and standards based on the common, contemporary high school science curriculum were provided when the World Book Company made available the complete standardizing samples for the general science, biology, and physics tests in its *Education and Adjustment* series (2). From the company's data the mean scores obtained by the students of each school used in the standardizing samples of the achievement tests were computed. These mean achievement scores were then adjusted to a common IQ* and empirical distribu-

*Regression coefficients of achievement against IQ were computed, and the mean achievement scores all adjusted to a single IQ according to the slopes of the regression lines.

tions of school achievement means constructed. These three distributions, one for each of the subject matter tests, were the standards against which the schools offering ninth-grade biology were compared.

Two schools had been located which were offering ninth-grade biology and tenth-grade physical science. The method of school selection introduced a bias since schools pioneering in curriculum change would be likely to have a better-than-average faculty and administration, but such, or an equivalent, bias was unavoidable. Students in the two schools were given the appropriate achievement tests at the end of the school year, mean scores were computed for various groups of students within each school, and these means adjusted to the common IQ to which the comparison distributions of school means had been adjusted.

Now to move to the testing of some of the values which it was thought would be fostered by the change in curriculum. Underlying the advocacy of ninth-grade biology is the assumption that ninth graders will do as well



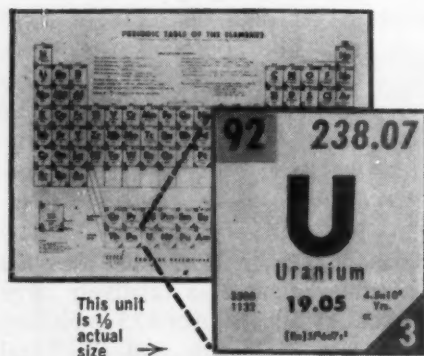
BROOKS PHOTO, BETHESDA, MARYLAND

Achievement is important in laboratory procedures as well as in written test scores.

in biology as tenth graders. The first problem was to test this assumption. This was done using the standardizing sample of the *Nelson Biology Test* modified to include tenth-grade students only.

The adjusted ninth-grade biology mean for the 303 students in one school, which we will call School A,

ranked 51 from the top among the 60 schools in the standardizing distribution; the 124 students in the second school, which we shall call School B, ranked 57 from the top. When the students of School A and School B were grouped according to their teachers, the results shown in Table I were obtained. The students in School B could not be



Another NEW LECTURE ROOM PERIODIC TABLE

Larger • Easy to Read • Colorful
Includes Atomic Data

Includes all elements and number of naturally occurring radioactive and stable isotopes. Shows atomic number in large type, also weight, density, boiling and melting points, electronic configuration, half-life, and important atomic constants for physics and chemistry. New large lecture room size, 62" x 52", in 4-colors on heavy plastic coated stock.



No. 12056 with wood strips and eyelets, each, \$7.50

CENTRAL SCIENTIFIC CO.

A Subsidiary of Cenco Instruments Corporation
1718-0 Irving Park Road • Chicago 13, Illinois
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

TABLE I

Ranks of Student Groups According to Teachers on the *Nelson Biology Test*

Teacher	1	2	3	4*
Rank	55/60	42/60	57/60	57/60
Number of Students.....	115	101	87	124

*Taught all students in School B

TABLE II

Differences between Expected Mean Scores and Obtained Mean Scores on the *Nelson Biology Test*

Teacher	1	2	3	4*
Obtained Mean Score	111	113	111	106
Expected Mean Score	116	116	117	113
Difference	-5	-3	-6	-7
Number of Students	115	101	87	124

*All students in School B

divided because only one teacher was involved. As can be seen, the classes of three of the four teachers ranked 55 or further from the top among the 60 school means.

To clarify the meaning of this low ranking, Table II shows how many standard score points the mean scores lay below what would be expected according to the mean intelligence quotients of the groups, assuming the schools were average schools.

It should be pointed out that the expected mean of all students on the test is 104 and that the higher expected means here indicate that the students used for this research had high average ability.

Using the concept of the standard error of estimate based on the regression of achievement upon IQ, these groupings of students were 1.7, .97, 1.7, and 2 standard errors of estimate below prediction. Thus three of the four groupings of students turned out to have obtained mean achievement scores which were lower than would be expected of 95 per cent of similar groups of students, and all were below prediction. These data did not produce statistically significant differences since the extensive variability of the large control sample did not permit such a determination.

Assuming then that the most determinative data available under the present state of knowledge indicates that achievement in biology is less at the ninth-grade level than at the tenth-grade level, is the difference large enough and of such a nature as to be educationally important? The answer to this question is largely a judgmental matter. Though such information as is presented in Table II is helpful, the answer would also depend on how well other educational objectives had been reached. It is possible that the loss in achievement might be compensated for by other educational gains.

I shall now turn to an examination of two such possible gains which were assumed to have been obtained from introducing ninth-grade biology in the two schools involved in this investigation. The hypothesis was made that ninth-grade biology and tenth-grade physical science would lead to a better knowledge of general science since the students who completed both courses would have had a two-year course in general science. This hypothesis was

tested with the *Read General Science Test* at the end of an elective tenth-grade physical science course. The results are shown in Table III.

TABLE III

Ranks of Mean Scores of Groups of Students after Ninth Grade Biology and Tenth Grade Physical Science Using the *Read General Science Test*

Teacher	1	2	3*
Adjusted Rank	24/57	28/57	5/57
Number of Students	98	21	31

*Students in School B

The results given in this table do not support the hypothesis except perhaps in the case of Teacher 3 where one must keep in mind that this is an instance where the teacher factor probably entered the picture. The students of this teacher might have done just as well had they just finished the ninth-grade general science course with him. In fact, the students of teachers in five schools out of the 57 in the test standardization group did perform just as well or better.

The hypothesis that high school physics students would do better work in schools offering ninth-grade biology

and tenth-grade physical science was tested in the same manner as were the other two hypotheses except that the *Dunning Physics Test* was the instrument. Here the results were encouraging as is shown in Table IV.

TABLE IV

Ranks of Mean Scores of Groups of Students after a Physics Course in the Eleventh or Twelfth Grade Using the *Dunning Physics Test*

Teacher	1	2	3*
Adjusted Rank	38/42	1/42	7/42
Number of Students	25	26	70

*Students in School B

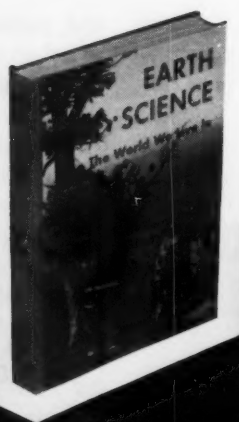
Teacher 1 had a low ability class most of the members of which probably should not have taken physics, or if they had done so, they should not have been rated on the basis of the test used. If one accepts this exception and looks upon the results as encouraging, it must be kept in mind that again they are not statistically conclusive. They do, however, point out that the ninth-grade biology, tenth-grade physical science sequence is not inimical to high achievement classes in physics.

On the whole the trends of results

Experiments planned for each grade level should be evaluated in terms of the objectives of the entire course.

BROOKS PHOTO, BETHESDA, MARYLAND





THE ACKNOWLEDGED LEADER—
in a beautiful 1960 edition

EARTH SCIENCE—

The World We Live In

Namowitz, Stone

The acknowledged leader among high school earth science texts, *EARTH SCIENCE—The World We Live In*, gains greater stature in its beautiful 1960 edition. It incorporates the latest research in all areas of earth science, of course, including the findings of the International Geophysical Year.

But this 1960 edition offers far more: an eight-page, four-color insert shows over 180 important minerals; an entirely new chapter deals with Minerals of Economic Importance; a new unit on historical geology, four chapters long, replaces the treatment formerly given in the appendix. There are so many new features, in fact, that you will discover them all only by examining the 1960 edition at your leisure.

D. Van Nostrand Company, Inc.

120 Alexander Street

Princeton, New Jersey

were negative toward the plan of ninth-grade biology and tenth-grade physical science. And, two sources in the literature reinforce this picture (3,4).

The limitations of the findings of this study illustrate the difficulty of evaluating a going-school situation objectively. One obvious limitation was the use of a single criterion test for each course. A statistical difficulty revolved around the problem that the many factors influencing test scores caused such a wide variability that the effects of the curriculum change alone could not be detected at a level which would be statistically significant.

In conclusion, it would seem that the change to ninth-grade biology and tenth-grade physical science should only be made if it is expected that there will be some loss in biology achievement and that other gains will make the change worthwhile. Since local factors, such as teacher interest, may greatly affect the success of the new program, it should be evaluated in terms of local objectives after giving it enough time for a fair trial. Inherent in the concept here presented is that the findings might indicate a return to the old program or a shift to another new program.

References

1. K. E. Brown and E. S. Obourn. *Offerings and Enrollments in Science and Mathematics in Public High Schools, 1956*. Pamphlet 120. Office of Education, U. S. Department of Health, Education, and Welfare. U. S. Government Printing Office, Washington, D. C. 1957. p. 12.
2. *Dunning Physics Test, 1951, Nelson Biology Test, 1950, Read General Science Test, 1951*. World Book Company, Yonkers-on-Hudson, New York.
3. P. F. Brandwein, F. Watson, and P. Blackwood. *Teaching High School Science: A Book of Methods*. Harcourt, Brace and Company, New York. 1958. p. 324-25.
4. P. Goldstein. "Concerning Ninth-Year Biology." *The Science Teacher*, 25:454-57. December 1958. Readers column—Criticism "Ninth-Grade Biology." *The Science Teacher*, 26:149. April 1959.
5. L. H. Heidgerd. *Effects of Changing the Typical Sequence of High School Science Courses to Ninth Grade Biology and Tenth Grade Physical Science*. Unpublished Doctoral Dissertation. University of Illinois, Urbana, Illinois. 1958.

THE



Times

LONDON, MONDAY, DECEMBER 26, 1859.

DARWIN ON THE ORIGIN OF SPECIES.*

There is a growing immensity in the speculations of science to which no human thing or thought at this day is comparable. Apart from the results which science brings us home and securely harvests, there is an expansive force and latitude in its tentacles, which lifts us out of ourselves and transfigures our mortality. We may have a preference for moral themes:—“The Homeric sage, who has seen and known much:—
“And banners, innately, councils, governments; yet we must and by one sea-god
“The whole system
“Are but dust while again,
“And is lightly laid again,
in comparison with the work of nature, to which science testifies, but which has no boundaries in time or space to which science can approximate.

But our knowledge of life is not confined to the existing world. Whatever their minor differences, geologists are agreed as to the vast thickness of the accumulated strata which compose the visible part of our earth, and the inconceivable immensity of the time of whose lapse they are the imperfect, but the only accessible witnesses. Now, throughout the greater part of this long series of stratified rocks are scattered, sometimes very abundantly, multitudes of organic remains, the fossilized exuviae of animals and plants which lived and died while the mud of which the rocks are formed was yet soft ooze, and could not have borne them. It would be a great error to suppose that these organic remains were merely the remains of the past. They are the very same as those which we find in the present. They are the same as those which we find in the present. They are the same as those which we find in the present.

Special Report on the Darwin Centennial Celebration ONE HUNDRED YEARS LATER

ON November 24, 1859, John Murray, publishers of Albemarle Street in London, issued the first edition of 1250 copies of a book whose first few sentences read as follows:

I will here give a brief sketch of the progress of opinion on *The Origin of Species*. Until recently the great majority of naturalists believed that species were immutable productions, and had been separately created. This view has been ably maintained by many authors. Some few naturalists, on the other hand, have believed that species undergo modification and that the existing forms of life are the descendants by true generation of pre-existing forms.

This book was, of course, Charles Darwin's *The Origin of Species by Means of Natural Selection or The Preservation of Favoured Races in the Struggle for Life*. The edition sold out on the first day of issue.¹

Charles Darwin (1809-1882) had been convinced that species were

mutable by his observations during his voyage on *H.M.S. Beagle* (1831-1836), and he had been gathering facts in support of this theory since 1837. In 1842, he produced a 35-page pencil-written abstract of his theory and two years later, in the summer of 1844, he prepared a 230-page hand-written, first draft of the *Origin*. The writing of the *Origin* took but a little more than a year. The following comment by Darwin on his writing habits may be of interest to the reader.²

Formerly I used to think about my sentences before writing them down;

² For a comprehensive insight into the life of Charles Darwin, the reader is referred to *The Life and Letters of Charles Darwin*, edited by Frances Darwin, Volumes I and II. Basic Books, Inc., New York, 1959. This book is the source on which all biographers of Darwin depend. It contains autobiographical recollections written by Darwin for his children. It was first published in 1888, reissued many times since, and was out of print for many years. The present issue is in recognition of the anniversary.

but for several years I have found that it saves time to scribble in a vile hand whole pages as quickly as I possibly can, contracting half the words; and then correcting deliberately. Sentences thus scribbled down are often better ones than I could have written deliberately.³

What kind of a man was Darwin? He was cautious, patient, modest, and self-critical. It was probably this combination of traits that was largely responsible for the delay in producing the *Origin*, and for the orderly, irrefutability of the evidence finally presented in the book. Eiseley says,

The *Origin* and its author have a history which runs silently and mysteriously through twenty years of ill health, lone effort, and corroding doubt.⁴

³ *Life and Letters*, p. 80.
⁴ Loren Eiseley, *Darwin's Century*, Evolution and the Men Who Discovered It. Doubleday and Company, Inc., Garden City, New York 1958. p. 142.

¹ A copy of a first edition of *Origin of Species* can be bought today for from \$200 to \$500, depending on condition. However, the reader is advised that a later edition, with a special introduction by Sir Julian Huxley, is available as a Mentor Book, published by the New American Library, and sells for 50¢.

In accounting for his success, Darwin says:

My habits are methodical, and this has been of not a little use for my particular line of work. Lastly, I have had ample leisure from not having to earn my own bread. Even ill-health, though it has annihilated several years of my life, has saved me from the distractions of society and amusement.

Therefore my success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these, the most important have been—the love of science—unbounded patience in long reflecting over any subject—industry in observing and collecting facts—and a fair share of invention as well as common sense. With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points.⁵

We get an insight into Darwin's methods from the following passage

⁵ *Life and Letters*, p. 85-6.

ALBERT TEACHERS' AGENCY COLLEGE BUREAU

Since 1885 three generations of the Albert Family have offered personalized efficient reliable service to educators at all levels from kindergarten through university on a *Nation-Wide* basis.

37 SO. WABASH AVE.
CHICAGO (3)
MEMBER NATA ILLINOIS

concerning an aspect of his voyage on the *Beagle*.

The investigation of the geology of all the places visited was far more important, as reasoning here comes into play. On first examining a new district nothing can appear more hopeless than the chaos of rocks, but by recording the stratification and nature of the rocks and fossils at many points, always reasoning and predicting what will be found elsewhere, light soon begins to dawn on the district, and the structure of the whole becomes more or less intelligible.⁶

Darwin's interest in natural history began rather early. At the age of eight he collected shells and minerals. His interest in collecting persisted, and, in his university days, he collected beetles as a hobby. His comments on methods of university teaching are noteworthy.

The instruction at Edinburgh was altogether by lectures, and these were intolerably dull, with the exception of those on chemistry by Hope; but to my mind there are no advantages and many disadvantages in lectures compared with reading.⁷

What was Darwin's contribution to the theory of evolution? It is well known that several of the early Greek philosophers had thought of the idea. Erasmus Darwin, the grandfather of Charles, wrote a poem called *Zoonomia* expressing the principle of evolution fifteen years before Charles was born. And in 1809, the great French biologist, Jean Baptiste Lamarck, described a fully worked-out evolutionary theory. Everyone is, of course, familiar with the work of Alfred Russel Wallace, a contemporary of Charles Darwin. Wallace, after expeditions in the Amazon Valley and the Far East, independently conceived the idea of natural selection. It was probably the knowledge of this discovery that stimulated Darwin to publish the *Origin*. Both men read their preliminary papers jointly at a meeting of the Linnaean Society in London in 1858.

Darwin's unique contribution was that he brought forth for the consideration of biologists, a storehouse of well-chosen facts which could be interpreted in only one way: in support of his theory of evolution and the mechanism of natural selection as the method of

evolution. The *Origin* has been called a master synthesis. Waddington evaluates the influence of the theory of evolution in the following statement.

In its effect on man's general mode of thought about the world, the theory of evolution is at least as far-reaching as the most important earlier contribution of science, namely, Newton's laws of motion and concepts of mass and force.⁸

What is our position on evolution today? From 1859 until about 1925, Darwinism came in for a great deal of criticism. Since that time, Huxley summarizes,⁹ a series of findings has resulted in the reconciliation of the apparent contradictions in Darwin's theory. These discoveries included the conclusive demonstration that acquired characters cannot be inherited; that continuous evolutionary change can be brought about by the accumulation of many, small, discontinuous mutations under the guidance of natural selection; the demonstration by R. A. Fisher in 1930 that heredity is particulate, i.e., dependent on distinct self-reproducing units or genes each of which could mutate into new self-reproducing forms; and the fact that most mutants are recessive.

Huxley says that,

Neo-Darwinism, as we may call the modern theory of gradual transformation, operated by natural selection acting on a Mendelian genetic outfit of self-reproducing and self-varying genes, is fully accepted by the great majority of students of evolution.¹⁰

Darwin gave us a new understanding and point of view. During the past one hundred years, scientists in many fields have engaged in research stemming from his discoveries and formulations.¹¹

⁸ S. A. Barnett. *A Century of Darwin*. Harvard University Press, Cambridge, Massachusetts. 1958. p. 5.

⁹ Charles Darwin. *The Origin of Species*. The New American Library (A Mentor Book), New York. 1958. (Introduction by Sir Julian Huxley), p. xii.

¹⁰ *Ibid*, p. xiii.

¹¹ For an account of the progress made in several fields, the reader is referred to *A Century of Darwin*, edited by S. A. Barnett, Harvard University Press, Cambridge, Massachusetts. 1958. This volume consists of fifteen articles prepared by authorities on Darwin's contributions to evolution and to other fields ranging from embryology to botany, the social sciences, and ethics.

⁶ *Life and Letters*, p. 52.

⁷ *Life and Letters*, p. 32-3.

The Darwin Centennial Celebration, held at The University of Chicago during November 24-28, 1959, was organized to take stock of the contributions of the theory of evolution to human culture during the past century.

The Celebration was conceived four years ago by Professor Sol Tax of the Department of Anthropology of The University of Chicago. During the past three years, forty-three scholars from all over the world were invited to examine the particulars of evolution from the vantage of their own special disciplines, and to prepare papers on the present status of evolutionary doctrine. These papers were interchanged among the specialists, and were carefully read, criticized, and revised.¹² The papers were also studied by the Celebration Committee in Chicago. After two years of study, it

¹² These papers will be published in 1960 by The University of Chicago Press in two volumes, entitled *The Evolution of Life*, and *The Evolution of Man*. These will be the first two volumes in a three-volume series entitled *Evolution After Darwin*, The University of Chicago Centennial.

became clear that the questions raised by the scholars could best be considered under five categories: The Origin of Life, The Evolution of Life, Man as an Organism, The Evolution of the Mind, and Social and Cultural Evolution. It was decided that each of these headings would serve as a subject for a separate panel discussion.

Among the forty-three scholars who prepared papers for the Celebration were: Marston Bates of the University of Michigan; MacDonald Critchley of the National Hospital, London; Sir Charles Galton Darwin, grandson of Charles Darwin; Th. Dobzhansky of Columbia University; Hans Gaffron of The University of Chicago; G. F. Gause of the U.S.S.R. Academy of Medical Sciences; Ralph W. Gerard of the University of Michigan; Sir Julian Huxley; Clyde Kluckhohn of Harvard University; Alfred L. Kroeber of the University of California, Berkeley; L.S.B. Leakey of the Coryndon Memorial Museum, Nairobi, Kenya; Hermann J. Muller of Indiana University; Alexander Van Muralt of the University of Berne; Fred Polak of the University of

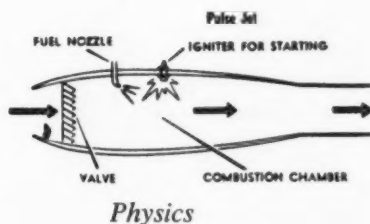
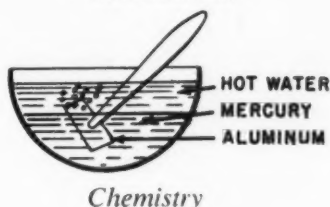
Rotterdam; Bernard Rensch of the University of Munster; Harlow Shapley of Harvard University; George Gaylord Simpson of Harvard University; N. Tinbergen of the University of Edinburgh; Leslie White of the University of Michigan; and Sewall Wright of the University of Wisconsin.

In the autumn of 1959, thirty members of the faculty and fifty selected graduate students from twenty departments of The University of Chicago studied the papers, and thought and talked through the issues in the study of evolution as seen under the five major headings. This group developed working documents that could serve as agenda for the five panel discussions.

The panelists, who were the authors of the original papers prepared for the Celebration, met several days before the start of the meetings to give final form to the agenda.

Some of the major questions listed in the agenda for the panel discussions are given below. In the time available, the panelists discussed many of the topics on the lists to determine whether there was general agreement, where qualifi-

COMBINES



PHYSICAL SCIENCE FOR PROGRESS

This new book by Pella and Wood *blends* the principles of chemistry, physics, and the earth sciences into the same unit; in fact, in no one unit does one subject appear alone. For an illustrated brochure describing PHYSICAL SCIENCE FOR PROGRESS in detail, clip this coupon and return it today.

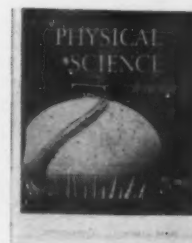
MAIL TO: Science Editor, Educational Book Division, Prentice-Hall, Englewood Cliffs, N. J.

Please send me an illustrated brochure describing PHYSICAL SCIENCE FOR PROGRESS.

Name _____

Address _____

City and State _____



NEGATIVE tropism



It happens in the best of classes—

even with the best of teachers.

If your maximum class response isn't *positive*,

perhaps you need to change your stimulus.

The right stimulus makes all the difference
in the living world . . .

And the right stimulus is the right text . . .

And the right text is

Kroeber, Wolff, Weaver

BIOLOGY

1960 EDITION

for 9th or 10th grade.

D. C. HEATH AND COMPANY

Your Heath sales representative can tell you about other outstanding Heath texts in physics, chemistry, and earth science . . . and about the new program in high school physics being prepared at M.I.T. for publication by D. C. Heath and Company in time for classroom use this Fall.

cation was required, and where research was needed to resolve the questions that were at issue.

PANEL I: The Origin of Life.

The naturalistic view of life.
The fact of Darwinian evolution.
The origin of living things from non-living matter.¹³
The structure of nucleic acid.
The uniformity of modern life on earth in its basic metabolic reactions.

Can life originate under present conditions on earth?¹⁴
The probability of life on other planets.¹⁵
The possibilities of transport of germs through space.

PANEL II: The Evolution of Life.¹⁶

The biologist's meaning of "life."
The self-replicating and self-varying properties of DNA.
The Lamarckian and vitalistic-orthogenetic theories of evolution.

The evolution of sex.^{17, 18.}

The study and analysis of the course of biological evolution as shown in fossils and as deducible from the data of taxonomy, comparative anatomy, ecology, and other sciences, etc.

The integration of diversification, transformation, and stabilizations into the process we called biological evolution.¹⁹

The formulation of general rules and the study of long-term trends operating in evolution.

¹³ There were many references throughout the discussion of this and related questions to the work of Stanley L. Miller (and Harold Urey) in the synthesis of amino acids under possible primitive earth conditions. Dr. Miller synthesized amino acids by sending electrical discharges through atmospheres consisting of methane, ammonia, hydrogen, and water. (See *Science*, 1953, 117: 528; *Journal of the American Chemical Society*, 1955, 77:2351; *Science*, 1959, 130:245.)

¹⁴ In his summary, Shapley said, "I think the answer is no—too much oxygen, too many bacteria . . . Can it occur in a test tube? The vote was yes . . ." The panelists' estimates for the length of time it will take to create life in a test tube, ranged from an upper limit of 1000 years to the lower limit offered by Panelist Muller who said, "I think I am going to shock you if you think you are optimists, because my answer is that those who go along with me in defining life as I do, will admit that the most primitive forms of life which deserve to be called living have already been made in the test tube."

¹⁵ Panelist Darwin was asked to comment on the probability of life existing on other planets. Using Chairman Harlow Shapley's estimate that there are probably in the neighborhood of 10^{20} stars likely to have planets, Darwin answered, "My calculations tell me that the probability of this being the only place where there is any life at all . . . is that though you have spun a coin sixty times, it came heads every single time." After some discussions, Shapley commented, "This is all speculation, but I have to call to your attention that the place we have found life—in fact, practice it—is on just an ordinary planet around an ordinary star, a run-of-the-mill star, that is at the edge of one galaxy that has at least 100,000 million other stars, and that galaxy is one of billions. Therefore, it is asking too much to think that this is that one place. I believe you would get heads once or twice in your sixty throws, all right."

¹⁶ In his introduction to Panel II, Chairman Huxley said, "As we saw yesterday, life appears to depend on these self-replicating and self-varying or mutating organic macromolecular strings of DNA, and in all organisms except a few viruses, so-called genetic and evolutionary information is carried by DNA organized into chromosomes in combination with protein. That is the basis of evolution."

¹⁷ In discussing the role of sex in gener-

ating a large number of gene combinations and a continual shuffling of genes, Panelist G. Ledyard Stebbins posed the question, "Is sex necessary?" To which Panelist Dobzhansky replied, "My answer is that it is at least desirable." To demonstrate the amount of variation generated by this process, Panelist Wright then made several calculations to show the huge number of combinations produced by relatively small numbers of gene loci each with just a few alternatives or alleles.

¹⁸ During the discussion of this topic, Panelist Ernst Mayr made the following very significant statement about the old belief that a gene controls a character. "Genes do nothing of the sort, particularly in higher organisms. The gene produces some kind of a gene product by itself, an enzyme or some kind of protein that we do not know about, and that is eventually fed into the total developmental stream. It is part of the total genetic pattern . . . and exaggerated statements have been made that every gene contributes to every character of the organism, and that every character of the organism is in part shaped by every gene."

"Therefore, let us keep in mind that a gene, for instance, which does such an unimportant thing as, let us say, controlling a slight matter of pigment pattern on the outside scale—that the very same gene may control longevity, aggressiveness, heat tolerance, all sorts of things. This is one of the most important findings of physiological genetics, and has more far-reaching effects on the interpretation of evolution. Therefore, let us never go back to the old concept that a gene controls a character."

¹⁹ At this point in the discussion, Panelist A. J. Nicholson reported on a fascinating case of natural selection that took place before his eyes as he was performing an experiment in population dynamics with the Australian blowfly.

AMERICAN COLLEGE BUREAU
and
FISK-YATES TEACHERS BUREAU
28 East Jackson Boulevard,
Chicago 4, Illinois
Leaders in nationwide placement service.
Member NATA

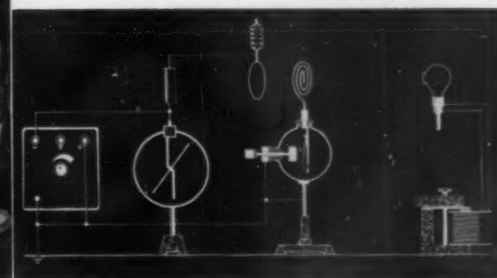


If you intend to visit Europe . . .

during the summer of 1960, plan to attend Leybold's advanced Physics Laboratory courses for teachers in Cologne, Western Germany. There will be twelve courses given weekly during the summer. The courses are given in English.

For information and reservations, write to:

J. Klinger, 82-87 160th St., Jamaica 32, New York
E. LEYBOLD'S NACHFOLGER
manufacturers of equipment for teaching Physics



The recent development of a "synthetic" theory of evolution linking the findings of many separate disciplines.

PANEL III: Man as an Organism.

The status of man in the biological world.
The course of human evolution.^{20, 21, 22}
The factors of human evolution.

PANEL IV: The Evolution of the Mind.

The influence of Darwin on the behavioral sciences.²³

The evolution of the mind and of behavior studied as any other organic function.^{24, 25, 26}

Human and sub-humans compared as to mind and behavior.

The relation of culture and the evolution of the mind.

The supplementing of genetic evolution by cultural evolution with the advent of civilization.^{27, 28}

PANEL V: Social and Cultural Evolution.

The unique ability of human beings to produce culture.²⁹

²⁰ Panelist Bates brought attention to Raymond A. Dart's *Adventures with the Missing Link*, Harper and Brothers, New York, 1959, and to Dr. Leakey's forthcoming book that will describe his discovery of *Zinjanthropus boisei*.

²¹ The response to the question, "Is *Homo sapiens* showing evolutionary traits?" was affirmative. The following were cited as examples: Increase in height, loss of hair, loss of wisdom teeth, loss of little toe, rounder head, and more sunken face.

²² Panelist Rensch said, in discussing this topic, that man's somatic future is unpredictable.

²³ In responding to a question on the extent to which computers think, Chairman

Gerard said that he was reminded of the following story. "A very fancy, new, high level electronic computer had been built that could do all sorts of things, and its creator fed into it a great deal of information about man's knowledge and behavior and all sorts of other things, and deposited the question, 'What is the level of human thought?' And the electronic gadget swirled and finally out came some typing and a card fell out of the machine, and it said, 'That reminds me of a story.'"

²⁴ In discussing this question, Panelist Tinbergen said, "We do know several animals that do use tools in the fullest sense of the word. One example is the Galapagos finch that lives rather like a woodpecker, but instead of having developed the woodpecker's bill it uses the spine of a cactus and probes in cracks and really gets at insects in that way. That is the use of a tool in the fullest sense of the word. All the individuals of the population, as far as is known, do that. Unfortunately, we don't know how it developed in ontogeny, but I think we can make a pretty good guess that this is not learned, although this is a guess and has not been analyzed.

"Another example is the case of the sea otter which carries a stone on its tummy, and when it has got hold of a mussel, it will float on the waves, and hammer the mussel against the stone, and crack the mussel in that way. That, I think, is the definition of the use of a tool. Again, the whole population does it, and again we don't know whether they learn it or not."

In a later panel discussion, Huxley said that it was his opinion that this type of behavior was determined genetically.

²⁵ In response to the Chairman's question, "Can you think of any example in animals where you can clearly see invention, sanctions transmission of knowledge . . . ?" Tinbergen replied, "As many of you may know, in Britain the titmice have developed a habit of opening milk bottles that are dropped at the front door in a hurry by the milkman, and which have been standing out for about two hours. From a study by Fisher on the spread of this act through Britain, we learn that this has arisen in many different places in Britain, and then, from that, it must have spread through the population, probably through the titmice of the same generation or another.

"There is no doubt that this is an example where a bird has done a new thing; not of one individual in a population, but of a

number of them, and that all of them have acted, in fact, as teachers . . . and this thing is now so widespread that most doors have a stone in front of them which is then put on top of the bottle of milk.

"This is a very unique thing. We know of very few examples of this . . ."

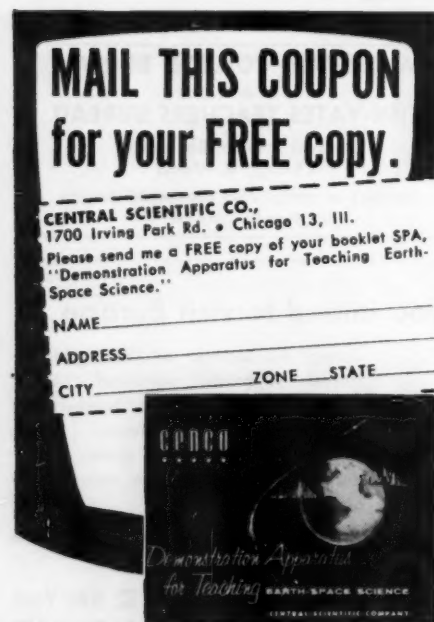
²⁶ In this discussion Panelist Critchley made the following interesting statement. "It seems to me that one of the principal gaps in our understanding of this smooth, orderly progression between the simple and highest representatives of the primates and the lowest representatives of *Homo sapiens* is to explain the abrupt introduction of language; because no matter how vocal an animal is, or how rich its knowledge of sounds, it cannot, strictly speaking, be spoken of as being endowed . . . with either speech or with language. At the very most, we can use the term, 'animal communication.' At the present there seems to be no real connection between animal communication and human speech or language."

²⁷ Panelist Critchley made the following concluding remarks: "My long-term prophecy is that in the remote future, the inhabitants of the earth will possibly use some form of communication other than words, other than linguistic systems; or else if they do not, they will have to use a vastly improved linguistic system because at the present time words are not enough."

²⁸ Panelist Von Muralt made the following concluding remarks: "I think that the situation of the neurologists is a bit the same as that of the astronomers. We are beginning to understand a little something about the functioning of one single motor unit, or of one single nerve cell. And the more we learn about it, the more we see that we are just at the beginning of understanding it.

"If we now think that in one gram of brain substance there are various millions of such cells interrelated, I think the only attitude which we can have toward the future is one of pessimistic courage."

²⁹ The working agenda for this panel included the following statement: "In man, biological evolution through gene shuffling, selection, and mutation can go on simultaneously with cultural evolution, and they are both operative. But cultural evolution has become much the more effective and dominant. The time seems past when biological evolution, in any single species other than man, or in all of them combined, could rival or surpass man's cultural evolution—the opposite seems already to be true."



This booklet has been prepared as an aid to teachers in the selection of apparatus for a modern course in Earth-Space Science.

Contains an outline of subjects as well as illustrations, descriptions and prices of required apparatus for each subject.



CENTRAL SCIENTIFIC CO.

A Subsidiary of Cenco Instruments Corporation
1718-O Irving Park Road • Chicago 13, Illinois
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

The independence of cultural evolution in *Homo sapiens* of gene differences between human subgroups or races.

Major breakthroughs in human cultural evolution.³⁰

Why most anthropologists and students of culture are less concerned with adaptation and its relentless flow than are biologists.

Culture history as a counterpart in anthropology and the social sciences to genetic evolutionary science.

A greater awareness of evolution and of the future as well as the past.³¹

The five panel discussions formed the nucleus of the Darwin Centennial Celebration. However, the Celebration was made even more stimulating and enjoyable by other events. One of these was a delightful, original musical play on the life of Darwin called, *Time Will Tell*. Dr. L. S. B. Leakey gave an illus-

trated lecture entitled, "The Origin of the Genus *Homo*" in which he reported his discovery of *Zinjanthropus boisei*, called by Leakey the "first unquestionable man." Sir Charles Galton Darwin, a grandson of the evolutionist, gave another illustrated lecture on "Darwin the Traveler." A feature of the Celebration was a special institute on Darwinism for high school biology teachers.

During the Celebration, the Federated Theological Faculty of The University of Chicago held an Institute on Science and Theology. The institute included lectures on the philosophical and theological implications of the theory of evolution, and a panel discussion to examine the relation of science and religion.

One of the highlights of the entire session was an address, "The Evolu-

tionary Vision," by Sir Julian Huxley at a special convocation.

We can find no better way of bringing this account to a close than by calling the attention of all teachers, and particularly science teachers, to a paragraph in Sir Julian's address which expresses what education should help man to attain.

The important ends of man's life include the creation and enjoyment of beauty, both natural and man-made; increased comprehension and a more assured sense of significance; the preservation of all sources of pure wonder and delight, like fine scenery, wild animals in freedom, or unspoiled nature; the attainment of inner peace and harmony; the feeling of active participation in embracing and enduring projects, including the cosmic project of evolution. It is through such things that individuals attain greater fulfillment.³²

³⁰ The major breakthroughs recognized by the panel are the following:

1. Food production, beginning gradually about 7000 B.C.
2. A syndrome centering around 3000 B.C. in which writing, metallurgy, urbanization, and political structures were first evolved.
3. The doctrinal and institutional organization of religions from about 600 B.C.
4. A grade of civilization characterized by rapid and progressive development of science, technology, invention, industry, and wealth, beginning about 1600 A.D.

³¹ Perhaps the most provocative of the statements made at the Celebration were these of Panelist Muller to this point. Muller outlined a program for the guidance of human evolution. Muller feels that individuals must recognize their responsibility "not only for the education and living conditions, but also for the genetic endowment, of the generations succeeding them." Man's attitude toward reproduction must be "more rational and more socially-directed." To achieve this end, Muller said, "some long entrenched attitudes, especially the feelings of proprietary rights and prerogatives about one's own germinal material, supported by misplaced egotism, will have to yield to some extent." Foster pregnancy, made possible through the techniques of artificial insemination, would be welcomed under this "new morality." This trend would be promoted as our techniques were improved to allow for the transfer, maintenance, testing, selection, and manipulation of both male and female germ cells or potential germ cells. This would make possible the adoption of children before fertilization ("pre-adoption"). These reproductive cells could have been derived from persons dead for many years. Banks of deep-frozen reproductive cells, possibly in culture,

could be maintained. We could thus store and use the best genetic material of all mankind—the genetic endowments of individuals such as Lincoln, da Vinci, and Shakespeare.

Muller also described a special kind of parthenogenesis which would make the nature of progeny even more predictable. The offspring obtaining his hereditary material entirely from one individual would be a genetic twin of that individual. This could be accomplished, Muller explained, by extracting the nucleus from a fertilized human egg, and inserting in its place another nucleus obtained from a cell of a pre-existing individual, specially chosen for outstanding

traits or potentialities. It would thus be possible to bring back to life outstanding persons long since dead, a physical immortality. Experiments of this kind have succeeded in creating parthenogenetic frogs. Muller feels that extending this method to mammalian and eventually to human fertilized eggs does not seem at all farfetched.

³² The full text of Sir Julian's convocation address and of the proceedings of the five panel discussions will be published in 1960 by The University of Chicago Press as *Issues in Evolution*, Volume III of *Evolution After Darwin*, The University of Chicago Centennial.



SWIFT® Stereoscopic and Widefield Microscope

Can Be Your Greatest Classroom Help

Swift Stereoscopic and Widefield Microscope is truly an outstanding instrument for classroom use. Deep, erect, three-dimensional image that is right-side-up gives the added advantage of no inverted image. Long working distance with splendid field of view 10mm at 20 power. Can be elevated to examine large Botanical specimens, or used over a culture dish. The stage is large and very useful. This Swift model is a must for every Science classroom.

Model SBW-1, vertical binocular body with interpupillary adjustment and diopter adjusting scale on right eyepiece tube, to correct for any difference between operator's eyes. Built in 2x objective, Widefield eyepieces 10x, 15x; power range 20x-30x. All optics are Swift Rubycoated to obtain best possible resolution. Stable, well-balanced stand with opaque center plate which is removable; large, durable stage clips. Instrument can be elevated on standard. Modern sand finish. Complete in wooden cabinet with lock and key.

Only **109⁸⁰** in lots of 5 or more

122⁰⁰ each.



SWIFT INSTRUMENTS, Inc.

1572 N. FOURTH STREET • SAN JOSE, CALIFORNIA

AO Reports on Teaching with the Microscope

Osmotic Action and Reaction or Social Life Among the Molecules

Here are two very short experiments that could be incorporated in a single class session. Both provide a brief, though enlightening introduction to the study of osmosis.

The first experiment by Dr. Frank E. Wolf presents the subject in its "growing phase". Mr. John A. Burns contributed the second experiment which is concerned with the "net movement" of osmosis. Both give an excellent visual demonstration of circulation and activity that takes place when a solvent and a solution tend to equalize their concentrations.

EXPERIMENT

Simulated Life Processes

By: Dr. Frank E. Wolf
Professor of Biology
State Teachers College
Fitchburgh, Mass.

Early in some biology courses, it is customary to make comparisons between living and non-living things. Sometimes a chemical garden demonstration is used to motivate an exploration into these differences. The garden meets some of the criteria of both categories: the "plants" apparently grow, reproduce, move, etc. All of these life processes are in some way dependent upon osmosis, for which the chemical garden is also an excellent demonstration. The following demonstration goes one step further. With the aid of the AO Spencer Cycloptic Stereoscopic Microscope, the process of *circulation* may be observed in a chemical garden "plant".

MATERIALS AND PREPARATION:

AO Spencer Cycloptic Stereoscopic Microscope, small containers such as one dram screw top vials or microtechnique test tubes, water glass (sodium silicate), ferric chloride and/or nitrates of cobalt, nickel, manganese, iron, lead, and copper; sulfates of copper, aluminum, iron, and nickel; chlorides of cobalt, manganese, and copper.



Fig. 1

Dilute the water glass one part to three parts of water for a relatively slow reaction;

or one to one for a faster reaction; forty percent is probably the most convenient, all-around strength.

PROCEDURE:

Fill a small container with the diluted water glass and add a small lump of ferric chloride or other compound listed. Observe under the stereoscopic microscope (Figure 1).

OBJECTIVES:

1. Observe the membrane-like sacs "growing" from the ferric chloride. Note that as the sac forms a tube, "cells" appear.
2. Focus on the inside of a growing tube and note the process of "circulation" taking place (Figure 2).

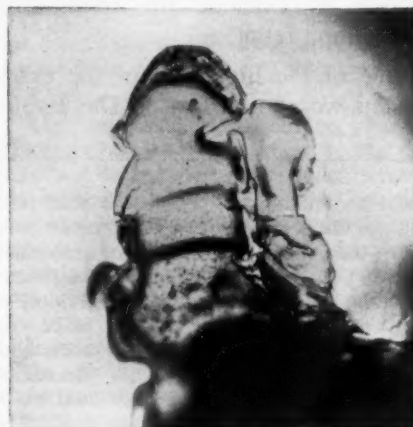


Fig. 2

NOTE: The stronger water glass solutions cause faster reactions with better views of circulation, but less well-defined cells. The weaker solutions are recommended for less experienced viewers because the reaction is slower and easier to follow. In either case, the demonstration proves exciting and quite interesting.

EXPERIMENT

To observe effects of molecular action included in study of osmosis.

By: John A. Burns
Vestal Central School
Vestal, N. Y.

MATERIALS AND PREPARATION:

Two AO Spencer No. 66 Student Microscopes, two microscope slides with cover slips, water, molasses, carmine red dye, and two probes or needles.

PROCEDURE:

Prepare two slides; the first a temporary mount of carmine dye in water, the second a temporary mount of the dye in molasses. Both may be easily made by dropping 2-3 drops of water (or molasses) on slide, then transferring a few grains of the carmine dye on the end of a needle into the water (or molasses) and stirring. Add cover slip, place each slide under high power (43X) of microscope (Figure 3), and focus until vibration of tiny dye particles is observed.



Fig. 3

OBJECTIVES:

1. Look for vibrating movement of dye particles in water slide. This "jiggling" of minute particles is called Brownian Movement, and is caused by rapid-moving water molecules hitting against visible dye particles in random fashion. Even though the water molecules can't be seen, their presence is revealed by their effect on the dancing dye particles.
2. Now look for slower, more sluggish vibration of dye particles in molasses slide. Large, slow-moving sugar molecules bounce the dye particles far less vigorously.

APPLICATIONS:

Students can visualize relative size of water and sugar molecules by observing their activity on dye particles. The small water molecules are active, move rapidly and therefore can be imagined as minute. By comparison the sugar molecules can be visualized as huge, due to their sluggish effect on the dye particles.

By combining the ideas of molecular sizes and activities with the concept of membrane permeability, an understanding of osmosis evolves. Students can then understand basic reasons why the standard carrot, potato, or beef bladder osmometer operate as they do, and thus can see how absorption can occur in plants, animals, and in the human body.

BIOLOGY TEACHERS! \$25 for your experiment. Our original offer was so well received and response so great that we were forced to discontinue it.

We're looking for more experiments now, so our offer is renewed. Send us your favorite experiment. If accepted for future ads like this one, we will promptly send you \$25. In the event of similar experiments, the one bearing the earliest postmark will be considered. Write Dept. C95.

American Optical Company

Instrument Division • Buffalo 15, New York

h Project lents

A black and white illustration of a woman with short, wavy hair, wearing a light-colored sweater with a dark, ribbed collar and cuffs. She is sitting at a desk, leaning forward with her right hand holding a pen and writing on a sheet of paper. Her left hand is resting on the desk near a small, vintage-style typewriter. The background is plain white. The text 'h Project' and 'lents' is overlaid on the left side of the image.

Science Teacher, Cleveland Heights High School, Cleveland, Ohio

39

You Can Depend on the GENATRON

● The MODERN Electrostatic Generator

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts—or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old-fashioned static machine!

NO FRAGILE PARTS— Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES— In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established directly upon the discharge terminal. The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the Cambosco Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a Cambosco development which has none of the shortcomings inherent in a belt with an overlap joint.

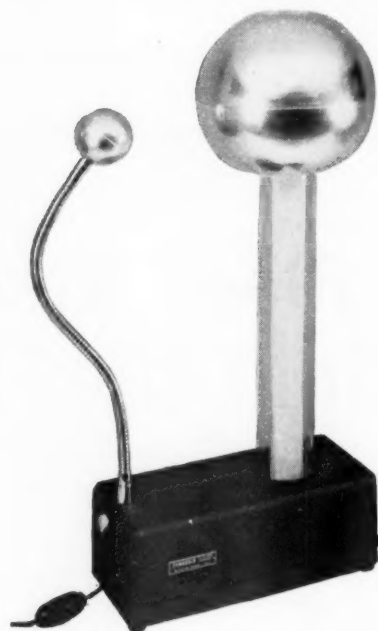
DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

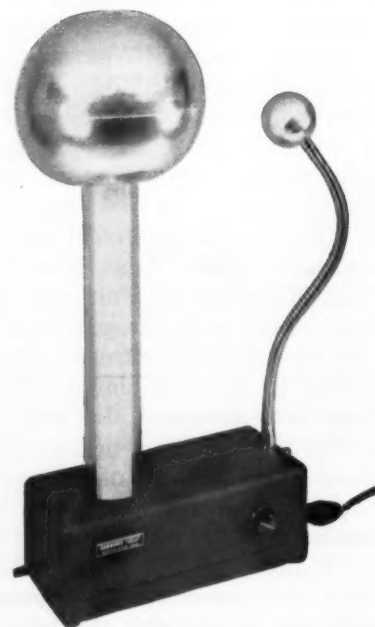
PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are respectively, 3 in. and 10 in. The base measures 5 1/4 x 7 x 14 in.



GENATRON, WITH MOTOR DRIVE

Operates on 110-volt A.C. or 110-volt D.C.
Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

No. 61-705\$98.75



GENATRON, WITH SPEED CONTROL

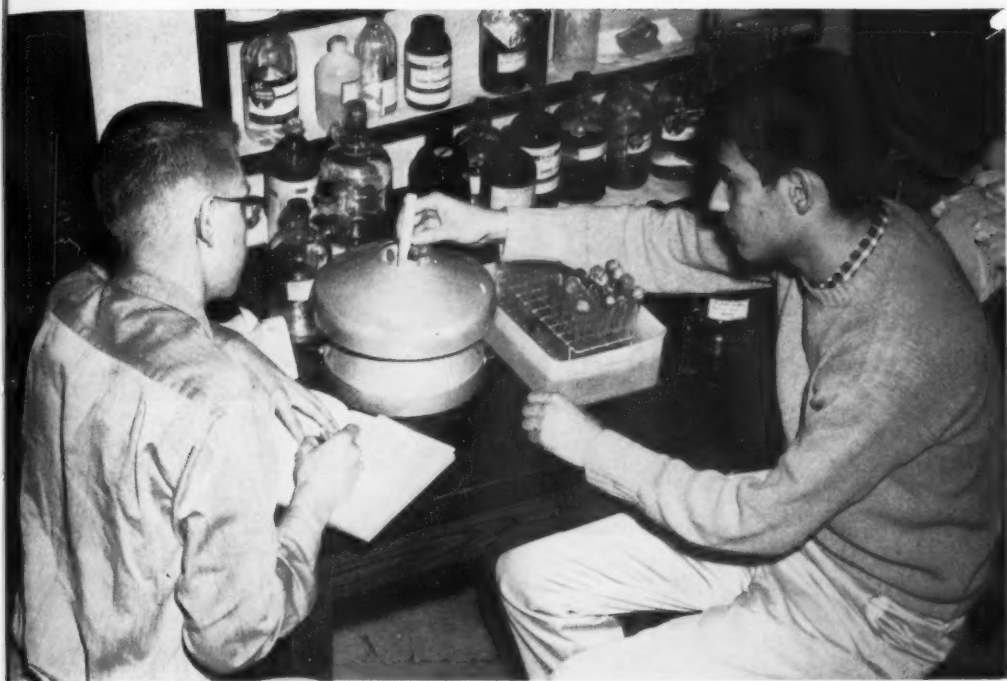
Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.

No. 61-708\$109.00

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708 \$3.00

CAMBOSCO SCIENTIFIC COMPANY

37 ANTWERP ST. • BRIGHTON STATION • BOSTON, MASS.



RONNIE SHERMAN, SCHOOL PHOTOGRAPHER

Ronald Kaye, right, starts to centrifuge tubes after adding protein precipitating reagents to blood. Homer Guffin records data. (Senior class, Cleveland Heights High School.)

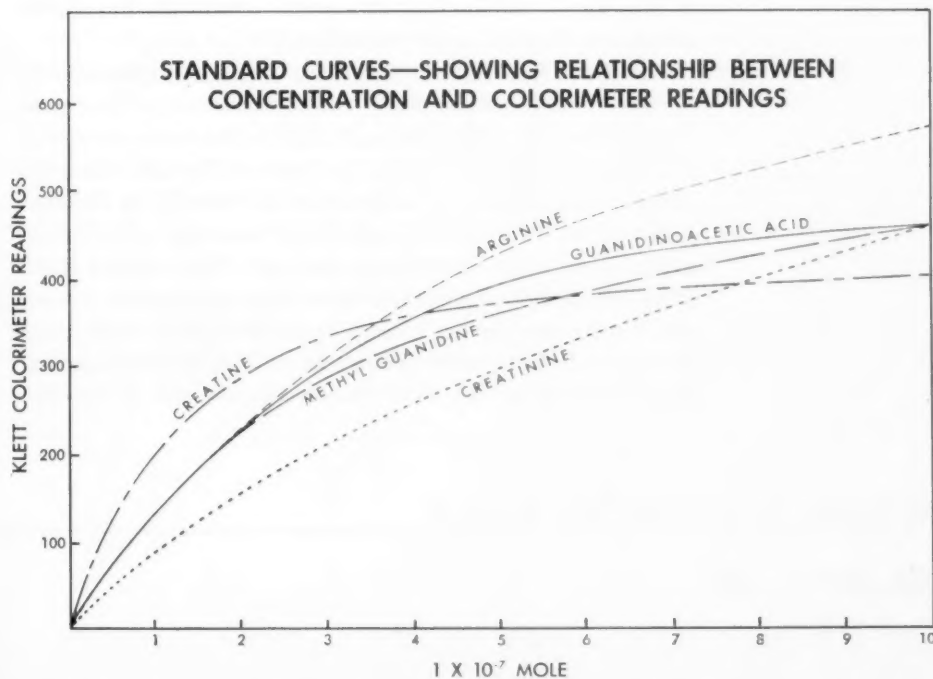
verted directly to milligrams per 100 ml of blood.

We used a modification of the Sakaguchi color reaction described by Van Pilsum *et al.* (*Journal of Biological Chemistry*, 222:225, 1956). The procedure had to be changed somewhat to utilize the equipment we had. Instead of a spectrophotometer we used a Klett colorimeter, and so required larger vol-

umes. Since several of the procedures could not be carried on one step following another, time intervals had to be varied to fit into our school day and individual student's schedule. Our readings were made at 520 $m\mu$ instead of at 515 $m\mu$ suggested by Van Pilsum. The green filter provided us with a wave length closest to the ideal.

Standard solutions were made of

FIGURE 1.



OUTSTANDING 16MM SCIENCE FILMS IN COLOR FOR ELEMENTARY AND HIGH SCHOOL GRADES

ANIMAL LIFE AT LOW TIDE

11 Min. \$110.00 Elem-Int-J.H.

AQUARIUM WONDERLAND

11 Min. \$110.00 Elem-Int-J.H.

COPPER MINING

14 Min. \$135.00 Elem-Int-JH.

DAMS

14 Min. \$125.00 Int-JH-SH.

DRILLING FOR OIL

22 Min. \$200.00 Int-JH-SH.

EARTHWORMS

11 Min. \$110.00 Pri-Elem-JH-SH.

HAWAIIAN ISLANDS, THEIR ORIGIN AND NATURE TODAY

10 Min. \$100.00 Elem-Int-JH-SH.

HOW ELECTRICITY IS PRODUCED

11 Min. \$110.00 Elem-Int.

INSECT COLLECTING

14 Min. \$135.00 Elem-Int-JH-SH

INSECT FOODS

14 Min. \$135.00 Int-JH-SH-Col.

LADYBIRD STORY, The

11 Min. \$110.00 Int-JH-SH-Col.

LITTLE ANIMALS

11 Min. \$110.00 K-Pri-Elem.

MICROSCOPIC WONDERS IN WATER

11 Min. \$110.00 Int-JH-SH.

TOADS

10 Min. \$100.00 Elem-Int-JH-SH.

WIND AT WORK

11 Min. \$110.00 Elem-Int.

WORKING WATER

14 Min. \$125.00 Elem-Int-JH.

—SALE ONLY—

Write for descriptive catalog,
Study Guides and Previews to

PAT DOWLING PICTURES

1056 S. Robertson Blvd.

Los Angeles 35, Calif.

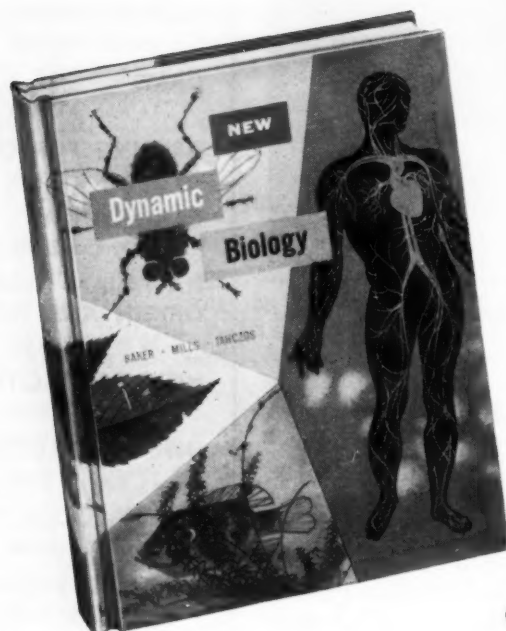
Rentals available from many University,
State, Regional and Public Libraries.

NEW

1959

Dynamic

Biology



by

Arthur O. Baker

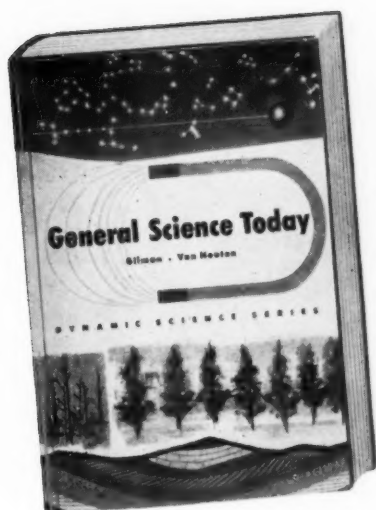
Lewis H. Mills

Julian Tanczos, Jr.

Over the years, you have probably relied on DYNAMIC BIOLOGY and DYNAMIC BIOLOGY TODAY to do the most effective teaching job for you. Today, NEW DYNAMIC BIOLOGY becomes the textbook for tomorrow. Make no mistake about it; it is a new text written by three of America's outstanding scientists whose distinguished talents are known across the nation.

NEW DYNAMIC BIOLOGY's "formal organization" permits a full and thorough study of each important biological function or life process. Each life process is presented in a separate chapter. This makes possible for the first time a clear systematic step-by-step picture of the world of biology.

NEW DYNAMIC BIOLOGY devotes far more space to functional color illustrations than any other biology text. There are 29 full pages of four color illustrations. Functional use of color enables the biology student to grasp important biological concepts with greater ease. This allows complex subject matter to be spread throughout the text and to be



GENERAL SCIENCE TODAY...

by Phil R. Gilman, L. F. Van Houten

... introduces your students to an elementary understanding of chemistry, physics, biology, and atomic energy, *not* in terms of abstract and difficult theoretical principles but in terms that will inform and show them how they can use this scientific knowledge in their adult life.

Short paragraphs written for easy comprehension explain scientific principles, and illustrations show their practical application in every-day life.

GENERAL SCIENCE TODAY gives students who will continue in science a solid basic understanding of all sciences ... it gives others a good insight into the application of science in their life.

presented step by step. NEW DYNAMIC BIOLOGY is the first book to succeed in avoiding crowding or oversimplification which has been characteristic of color illustrations in science texts. The many magnificent color illustrations and pictures appear adjacent to the text copy which explains them.

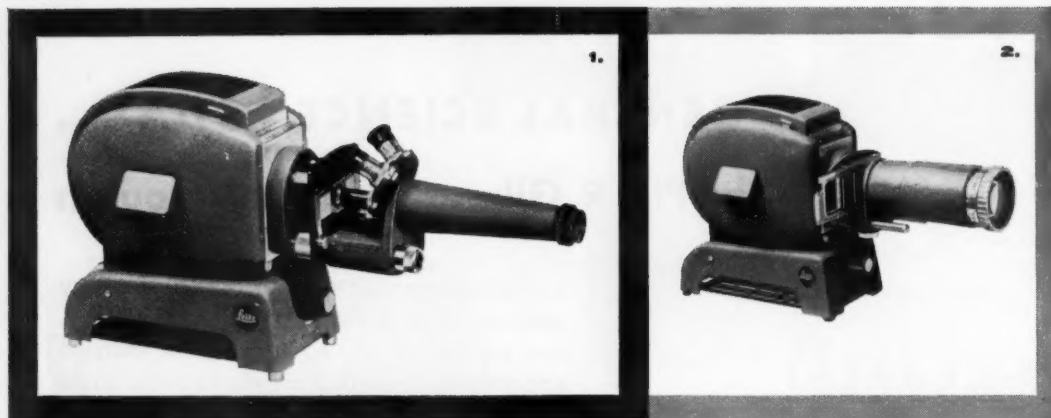
A NEW DYNAMIC BIOLOGY teacher's manual accompanies the text with tests and many other suggestions on new educational approaches to biology.

No one knows better than you, the biological challenge of our times. Your imaginative teaching role is a demanding one and we deeply feel you will find NEW DYNAMIC BIOLOGY the only reliable and indispensable up-to-date text through which you can directly make the teaching of biology dynamic and meaningful to the future citizens now sitting in your classroom.

Rand McNally will be pleased to send you more complete information on NEW DYNAMIC BIOLOGY. Write:

Rand McNally & Company

Box 7600, Chicago 80, Illinois



switch in seconds { *from projection of microscope slides to
projection of transparencies with the*

LEITZ PRADO MICRO-PROJECTOR

The ultimate in convenience for use in classroom, conference room or lecture hall, the PRADO Micro-Projector delivers screen images of unrivalled brilliance, clarity and definition. With Micro Attachment it produces magnifications up to 2400x on screens at a distance up to 40 feet; with a film slide carrier and lens inserted, the PRADO projects 2" x 2" or of 2 1/4" x 2 1/4" transparencies. And you can switch from micro to film slides in seconds—easily. The revolving nosepiece of the Micro Attachment holds three objectives: 3.5x, 10x and 25x. The high power objective is equipped with spring-loaded mount. Micro attachments are available which allow the stage to be placed in a horizontal position to accommodate wet mounts.

Light from the 500-watt lamp is projected through aspheric condensers in the PRADO, which is blower-cooled.

The PRADO Micro-Projector is portable, and may be carried easily from room to room and used wherever there is an electrical outlet.

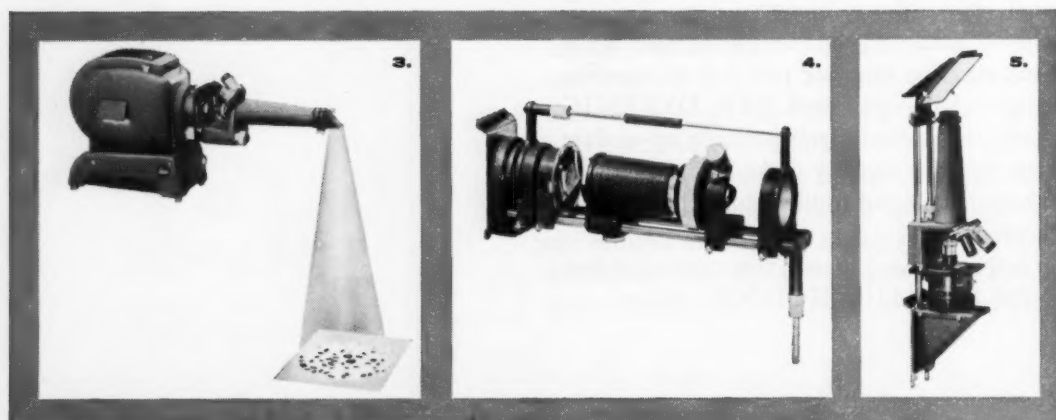
For illustrated PRADO Micro-Projector Brochure, write to Dept. ST-11.

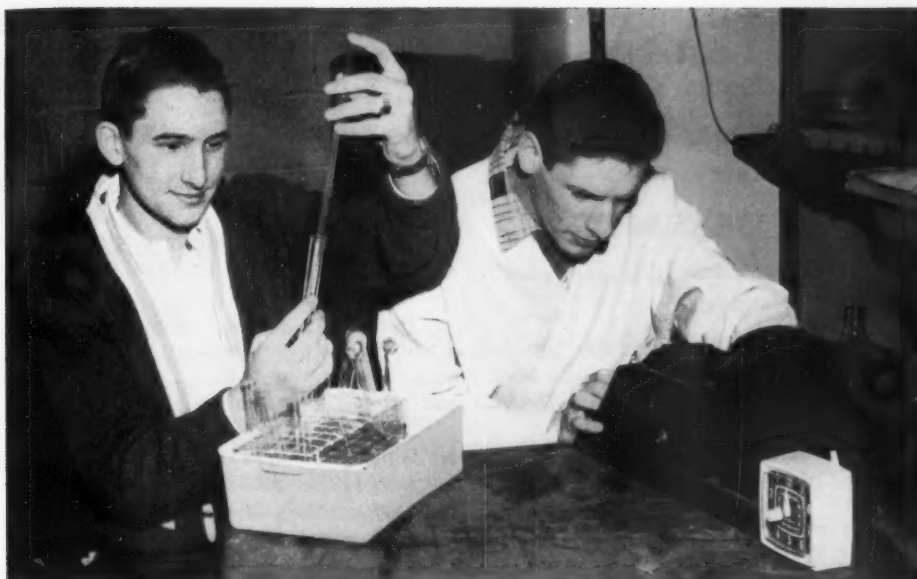
1. PRADO as Micro-Projector for microscopic slides 2. PRADO as standard projector for film slides 3. Attachable reflecting prism for tracings 4. Polarizing Attachment for polarization demonstration 5. Large Vertical Micro Attachment for wet mounts



E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N.Y.
Distributors of the world-famous products of
Ernst Leitz G.m.b.H., Wetzlar, Germany—Ernst Leitz Canada Ltd.
LEICA CAMERAS · PROJECTORS · LENSES · MICROSCOPES · BINOCULARS

32499





RONNIE SHERMAN, SCHOOL PHOTOGRAPHER

Barry Bassett and Steve Ellis, seniors. Barry adds reagents to tubes in ice bath while Steve makes colorimeter readings.

each nitrogen compound to contain X_1 0.1μ mole/0.1 ml, so that one milliliter of solution was equivalent to 1×10^{-7} moles. (Figure 1.)

The Sakaguchi color reaction can be performed directly for guanidinoacetic acid, arginine, and methyl guanidine. The procedure used is as follows:

1. The colorimeter tubes containing solutions to be measured are chilled in an ice bath.
2. 1.0 ml of alkaline-naphthol-thymine mixture is pipetted into the tubes.
3. After mixing, 0.4 ml of NaClO solution is added with immediate mixing.
4. Exactly one minute later, 0.4 ml of

$\text{Na}_2\text{S}_2\text{O}_3$ solution is added with immediate mixing.

5. The tubes are read at 520 $m\mu$.

Creatinine, to be read colorimetrically by this procedure, must first be converted to methylguanidine. This is accomplished as follows:

Tube 1 (Reagent tube)

1. Add 2 drops of o-nitrobenzaldehyde.
2. And 0.4 ml of 1.25 N NaOH.
3. Mix and let stand 20 minutes.
4. Add 1 ml phosphate buffer- H_2SO_4 mixture and mix.
5. Heat in boiling water bath for 10 minutes.

Robert Lewis uses the analytical balance.

RONNIE SHERMAN, SCHOOL PHOTOGRAPHER



"...truste wel that alle the conclusions that han be founde, or ellys might be founde in so noble an instrument as is an astrelabie ben unknowe parfitly to eny mortal man in this REGIOUN."

Geoffrey Chaucer,
"A Treatise on the Astrolabe," 1391.



Chaucer's treatise, written for his son, explained the most advanced scientific astronomical instrument of the time, the astrolabe. Today's "mortal man"—and child—have the privilege of studying astronomy and the space sciences with the aid of the precision engineered Standard Model Spitz Planetarium.

For information write:
DEPARTMENT S

SPITZ LABORATORIES, Inc.

YORKLYN, DELAWARE

4 OUTSTANDING TEXTS

THOROUGHLY TESTED IN COLLEGE AND HIGH SCHOOL COURSES

PRINCIPLES OF PHYSICAL SCIENCE

BY FRANCIS T. BONNER, *State University of New York*,
AND MELBA PHILLIPS, *Washington University*

"Few beginners' texts offer so wide a scope, so much that is technical with so little that is mathematical, and so little of condescension or evasion. The book merits consideration not only for the liberal arts science course but for public education and secondary school teacher training."

American Journal of Physics
736 pp, 349 illus, 1959—\$8.75

INTRODUCTION TO CONCEPTS AND THEORIES IN PHYSICAL SCIENCE

BY GERALD HOLTON, *Harvard University*

"The best guide this reviewer has seen for those interested in giving an introductory course in physics with a philosophical approach to the experimental and theoretical interpretation of the physical world."

Physics Today
650 pp, 260 illus, 1952—\$8.00

FOUNDATIONS OF MODERN PHYSICAL SCIENCE

BY GERALD HOLTON, *Harvard University*, AND DUANE H. D. ROLLER,
University of Oklahoma, under the editorship of Duane Roller

"Its wide adoption will do much to improve the quality of freshman instruction in physics. It will be a valuable addition to the reference shelves of professional physicists and of physics instructors at all levels from high schools to graduate schools."

Physics Today
782 pp, 270 illus, 1958—\$8.75

COLLEGE PHYSICS, Third Edition

BY FRANCIS WESTON SEARS, *Dartmouth College*,
AND MARK W. ZEMANSKY, *City College of New York*

The new edition of an internationally popular text for students of liberal arts, science and engineering. Only elementary trigonometry is assumed; physical principles are emphasized. The numerous changes and additions make the book even more teachable and understandable.

Complete, 1024 pp, 765 illus, 3rd ed. 1960—\$9.75
Part 1, 468 pp, 328 illus—\$5.75
Part 2, 559 pp, 437 illus—\$5.75

Also excellent for reference and for teacher training

EXAMINE THESE BOOKS AT OUR NSTA CONVENTION EXHIBIT, BOOTH 95



ADDISON-WESLEY PUBLISHING COMPANY, Inc.
Reading, Massachusetts, U. S. A.

- Cool.
- Proceed with color reaction.

Tube 2 (Control tube)

- Add 1.0 ml phosphate buffer- H_2SO_4 mixture.
- Add 0.4 ml of 1.25 N NaOH.
- Proceed with color reaction. Add 2 drops o-nitrobenzaldehyde just before addition of the NaClO solution.

Creatine must first be converted to creatinine and then to methylguanidine before the color reaction may be performed.

Tube 1 (Reagent tube)

- 1.0 ml citrate buffer added.
- Tube covered with glass marble and heated 2 hours in boiling water bath.
- Cool to room temperature.
- Add 0.4 ml of 1.66 N NaOH.
- Creatinine procedure follows.

Tube 2 (Control tube)

- Add 1 ml of 0.15 citrate buffer, pH 2.2.
- Add 0.4 ml of 1.66 N NaOH.
- Add 1.0 ml phosphate buffer- H_2SO_4 mixture.
- Tube is ready for color development.

After standard curves were drawn for each of the compounds, we planned to go ahead with the same determinations on blood samples. Four hospitals in the Cleveland area generously agreed to send us blood remaining from their work. We had hoped initially to use hospital values for nonprotein nitrogenous blood constituents. We found, however, that only blood urea nitrogens are done routinely and that we would have to do the determinations ourselves. The quantities of blood aliquots were often so low that we had to pool two and more and even the BUN readings furnished us could not be used. We added to our procedures NPN determinations (Koch and McMeekin, *Journal of American Chemical Society*, 46:2066, 1924), urea nitrogen (method of Karr, *Journal of Laboratory & Clinical Medicine*, 9:329, 1924), and uric acid nitrogen (method of Folin, *Journal of Biological Chemistry*, 101:111, 1933 and 106:311, 1934).

Analyze the results. To date we have reports on only ten pooled blood samples of patients with nephritis and these are not all complete.

From the readings tabulated so far we have to conclude that there is little

elevation, if any, of guanidinium compounds in the blood in kidney disease.

The following represents averages of the pooled samples:

1. Total nonprotein nitrogen	81.66	mg/100 ml blood
2. Urea nitrogen	46.33	
Uric acid nitrogen	26.74	} 78.07 mg total
Creatinine nitrogen	5.00	
3. Undetermined nitrogen	3.59	(difference) 1 minus 2
4. Arginine nitrogen	0.34	
Methyl guanidine N	0.55	} 0.98 mg
Guanidinoacetic acid N	0.09	

The latter three guanidinium compounds make up 7 per cent of the total

nonprotein nitrogen and 24.5 per cent of the undetermined nitrogen.

Conclusions. Many more results are needed before any conclusions can be drawn. If the guanidinium compounds make up 25 per cent of the rest nitrogen, we need another hypothesis to start looking for the yet undetermined 75 per cent. The problem of determining the constituents of the rest nitrogen of the blood is far from solved. The value in the project, aside from finding results, is the example of encouraging cooperation between students in working as a team on a research problem.

RECOMMENDED AIDS for SCIENCE TEACHING!



- School Science Equipment — chemicals, apparatus, teaching aids.
- Many available under NDEA — Title III.



Set "A" — 79 pieces of the finest quality apparatus — ideal for elementary schools. **\$59.50**

SCIENCE KIT — Recommended by Science Text Publishers, ACEI and 32 State Depts. of Education, SCIENCE KITS are found in schools in every state.

The original, complete, portable laboratory for elementary schools, it contains over 80 pieces of quality apparatus, manuals (text-correlated) and Blough & Blackwood's Teaching Elementary Science. **\$39.95.**

SCIENCE KIT, JR. — Portable laboratory with all the equipment needed for successful science instruction from kindergarten through Grade 3. Teacher's Manual of Experiments and Teaching Elementary Science Bulletin included. ACEI recommended. **\$21.75.**

SCIENCE KIT LAB — for the enlarged science programs in elementary and junior high school. Sturdily constructed of maple, the cabinet has a heat and chemical-resistant top; stainless steel sink; plenty of storage space; bulletin and peg board; three electric outlets; 4" rubber-tired, ball-bearing wheels (two equipped with swivels and brakes for easy positioning). **\$279.00.**

Set "B" — 134 pieces of equipment selected especially for Junior H. S. use. **\$99.50**

Science Kit will save you time...effort...money

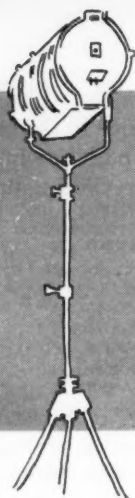
- Freight Not Included in Above Prices.
- CURRENT Price Catalogs Available on Request.
- Replacement Service — send for free circulars.

SCIENCE KIT, Inc. Serving Educators Since 1939
BOX 69 — TONAWANDA, N. Y.

SPOTLIGHT

on

RESEARCH



Research on the Teaching of Elementary School Science

By PAUL C. BURNS

Assistant Professor, School of Education, The University of Kansas, Lawrence, Kansas

IN this article a brief review is presented of several studies at the elementary science level which deal with instructional methods and procedures. It is hoped that many of our readers will be able to discover applications of some of the findings to their own teaching techniques.

A study was made of the effectiveness of two methods of teaching science in fourth, fifth, and sixth grades by Stefaniah (14) to determine whether teachers taught by the lecture method did a more effective job than teachers exposed to the individual laboratory method. Experimental and control groups of in-service teachers participated with the instructions centered around a list of forty principles of science. Pupils were pre- and post-tested to determine gains or losses in interests and content. Results seemed to favor teaching of those instructed by individual laboratory method, although the difference was not marked.

Baker (1) studied the reactions of pupils to science experiments by conducting a series of experiments in grades three through six. No explanation or comment was given during the experiment, but following it the children were asked, "What happened and why?" It was found that many pupils could interpret and generalize without help of the teacher.

An early study reported by Beauchamp (2) sought to determine the relative efficiencies of two different

methods of study, semi-directed study and directed study, of science materials. He came to the general conclusion:

Specific training in finding the central thought of a paragraph, determining the question one must be able to answer in order to obtain adequate understanding of a topic, and reading an entire block of material through for its general plan, results in a more thorough comprehension of subject matter than undirected study on the same material.

Robertson (12) carried out an experiment to compare the relative effectiveness of a "guidance-outline" method and a "developmental-discussion" method. He selected six units of work and then taught one group by the developmental-discussion method in which discussion was based on the children's interest. He taught the other group by guidance. With guidance, the children worked individually receiving aid when needed. Groups were equated on basis of reading ability and previous science achievement, and other necessary factors were held constant. In addition, the groups rotated during the course of the experiment. The groups were tested for immediate and delayed recall; the developmental-discussion group did slightly better on both tests.

Haupt (8) reported the results of an experimental study in which a philosophy of science education, as set forth in the Thirty-first Yearbook of the National Society for the Study of Education, was applied. He selected one

objective of instruction (consideration of energy relationships between sun and green plants) and used it as a basis of teaching. He equated and pre-tested groups of children in grades one through six, instructing them in respect to the objectives. Then he re-tested them. He concluded that the same instructional objective could be used at all grade levels; that the same mental activities occur at all levels, differing only in complexity; and that children generalize at all levels.

Should science be integrated with other elementary school subjects? Mallinson (9) made an analysis of elementary science and geography books to discover what similarities existed in the two subject matter areas. He found that similarity did exist in the areas of agriculture, air, earth as a planet, forest, fishing, and mining. He felt that where similarity exists, the two subjects could be properly integrated.

Integration of science with mathematics at the seventh- and eighth-grade levels was investigated by Gorman (6). He selected a science and mathematics text and from them determined common topics of study. For the experimental group, he constructed a workbook consisting of common problems and activities. The control group studied science and mathematics independently but covered the same topics. The groups were equated and the results of the study, based on achievement test scores, indicated no appreciable difference in efficiency of the two methods of instruction.

How effective are various multi-sensory aids? Greene (7) reported a comparative study of efficiency of dramatic and non-dramatic methods in teaching science to fifth-grade children. In the experiment two plays were used as teaching procedures, teacher-written ones and pupil-written ones. The control groups used their usual procedures. He concluded:

Children learn factual information only slightly, if any, more rapidly when taught by dramatic rather than by a non-dramatic method, but the following desirable learnings developed more strongly: speech arts; poise; group organization; social interplay.

Silano (13) conducted an experiment to test results of using drawings as learning aids. He selected two groups of seventh graders and tested them and determined their knowledge of air-

planes. One group was given instruction about planes in a traditional manner; the other group was given usual instruction and in addition was taught to draw a well-proportioned airplane. The two groups were again tested and the experimental group missed fewer questions. One fault of this study, however, was the failure to equate groups at the beginning of the study.

The value of radio broadcasts has been studied. Carpenter (4) reported two studies. In the first he described the results of an experiment in teaching science by radio in the Rochester School of the Air. The radio broadcast followed a prescribed course of study, twice per week for one semester, thirty-minutes in length, followed by twenty minutes of class discussion. Results of final achievement tests administered to "radio" class and "traditional" class indicated that "radio" class did only as well as "traditional" class.

On the other hand, Brewer (3) worked with experimental and control groups in New York City in testing radio as an aid to instruction in elementary science. He used five broadcasts on certain concepts of nature. With elaborate statistical techniques he secured the results that radio programs do serve as definite stimulus to further activities. Miles (11) came to the same conclusion when the broadcast had been planned carefully and taught specifically as in the experiment designs procedure.

Recorded science lessons were reported by Carpenter (5). Forty science lessons, ten minutes in length, were recorded. These were heard by approximately 11,000 children. A science interest test was given at the beginning and end as well as a science achievement test. From the results, records appeared functional in increasing factual knowledge, skills, and interests.

Martin (10) carried on a study to discover relationships of "community resources and use of the tape recorder." The tape recorder was a very satisfactory and successful aid in teaching, he concluded from his study.

What summary, in the form of trends and conclusions, may be made at this time relative to research and its implication in the elementary school science area?

1. There appears to be of recent date an increased proportion of learning studies as opposed to curricular

studies in the field of elementary science.

2. Since the early studies there has been marked progress in the refinement of statistical procedure used in the studies.

3. Studies would appear to indicate that efficient teaching of science demands definitely organized experiences, rather than reliance on incidental methods.

4. Most studies favor organization of science around cores of subject matter, supplementing instruction by means of demonstration, discussion, drawing, and experiments. Data from several studies would appear to strengthen the case for a greater laboratory approach at the elementary level. Availability of material no doubt has some effect upon the type of instruction typically used.

5. As yet there appears to be no final experimental evidence to indicate the value of integration of science with other elementary subjects.

6. Research seems to indicate that multi-sensory devices are helpful in developing interest and possibly toward increasing pupil factual knowledge of science. An additional value is their help to elementary teachers who may lack subject matter background in the field of science.

7. Major emphases in the past few years in elementary science research appear to be in the field of audio-visual aids and other such devices to learn more about teachers' ability to gain pupil interest.

8. There appears to be a great deal of research still needed with respect to teaching of scientific attitudes and problem-solving skills. Although these are accepted as major objectives of science instruction, it would appear that most teaching still centers around dissemination of factual information, even where problem or unit approach is mainly used. Another area that needs investigation is that of proper use of laboratory exercises.

9. No significant advantage of any one method over another has been definitely proven. All methods are valuable if properly used. While some procedures are superior in a given situation, in general, they all have value at one time or another. Selective use of many techniques is probably still the most advantageous procedure for the teacher.

Bibliography

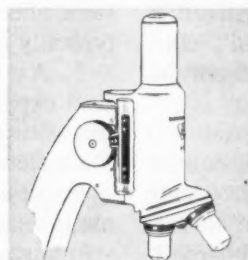
1. Tunis Baker. "Effective Uses of Science Experiments in Elementary School." *NEA Addresses and Proceedings*, 79:584-5. 1941.
2. Wilbur Beauchamp. "A Preliminary Experimental Study of Techniques in Master of Subject-Matter in Elementary Physical Science." *Studies in Secondary Education I, Supplementary Educational Monographs*, 24. The University of Chicago, Chicago, Illinois, January 1923.
3. Lyle Brewer. "Radio as Aid to Instruction in Elementary Science." *Science Education*, 23:63-8. February 1939.
4. Harry A. Carpenter. "Science on Rochester School of the Air." *Science Education*, 21:77-81. April 1937.
5. Harry A. Carpenter. "An Experiment with Recorded Science Lessons." *Science Education*, 24:181-6. April 1940.
6. Frank Gorman. "An Experiment in Integrating Seventh and Eighth Grade Science and Mathematics." *Science Education*, 27:130-4. December 1943.
7. Robert Greene. "A Comparative Study of Efficiency of Dramatic and Non-dramatic Methods in Teaching Science to Fifth Grade Children." Doctor's Dissertation. Cornell University, Ithaca, New York. 1937.
8. George W. Haupt. "An Experimental Application of a Philosophy of Science Teaching in Elementary School." *Science Education*, 28:234-8. December 1934.
9. George Mallinson. "Relationship Between Work of Elementary Science and Geography Teachers." *Journal of Geography*, 44:206-10. May 1950.
10. Evelyn Martin. "Community Resources and Tape Recorder." *Teaching Tools*, 111:68. Spring 1956.
11. Robert J. Miles. "Evaluation of Broadcast and Recordings for the Science Classroom." *Science Education*, 25:205-6. April 1941.
12. Martin Robertson. "Study of Effectiveness of Two Methods of Teaching Elementary Science." Doctor's Dissertation. University of Michigan, Ann Arbor, Michigan. 1930.
13. Alfred Silano. "The Drawing as a Learning Aid in Science." *Science Education*, 34:51-5. February 1950.
14. E. Stefaniah. "A Study of Two Methods of Teaching Science in Grades 4, 5, 6." Doctor's Dissertation. Boston University, Boston, Massachusetts. 1955.

Now Even More STUDENT-PROOF!



Two new budget-saving reasons why Bausch & Lomb outwears them all

★ *Exclusive* NEW LIFETIME BALL-BEARING FOCUSING



To resist rough handling for *even more* extra years of use, B&L Standard Teaching* Microscopes now feature the most wear-free focusing ever offered in the school budget range. Eight stainless steel ball bearings in hardened steel raceways float the slide

and assure perfect smoothness, precise centration. An automatic stop prevents removing the tube and eliminates the possibility of stripping the rack gear. This new design gives you *even more* trouble-free service—and added benefit with no increase in price—to make your best buy even better.

★ *Exclusive* NEW FORCE-PROOF CLUTCH

Prevents damage to fine adjustment mechanism, objectives and specimens. When the end of the fine focus travel is reached, the safety clutch takes over—even if the fine focus knob is forced beyond its range, there's no damage to any part of the focusing assembly. Now your best buy is even more student-proof.

★ *Plus* Standard size, standard operation, with laboratory-grade optics, made in America by Bausch & Lomb. Lifetime warranty; nation-wide service by qualified B&L dealers. Meets Council of Chief State School Officers' Purchase Guide requirements, Nos. 2625, 2645, and 2650. As low as \$112.50 each, in lots of five.

*Trademark, Bausch & Lomb Optical Co.

BAUSCH & LOMB OPTICAL CO.
78003 Bausch St., Rochester 2, N. Y.

- ☐ Please send Catalog D-1079.
☐ I'd like a demonstration of B&L Standard Teaching Microscopes.

NAME

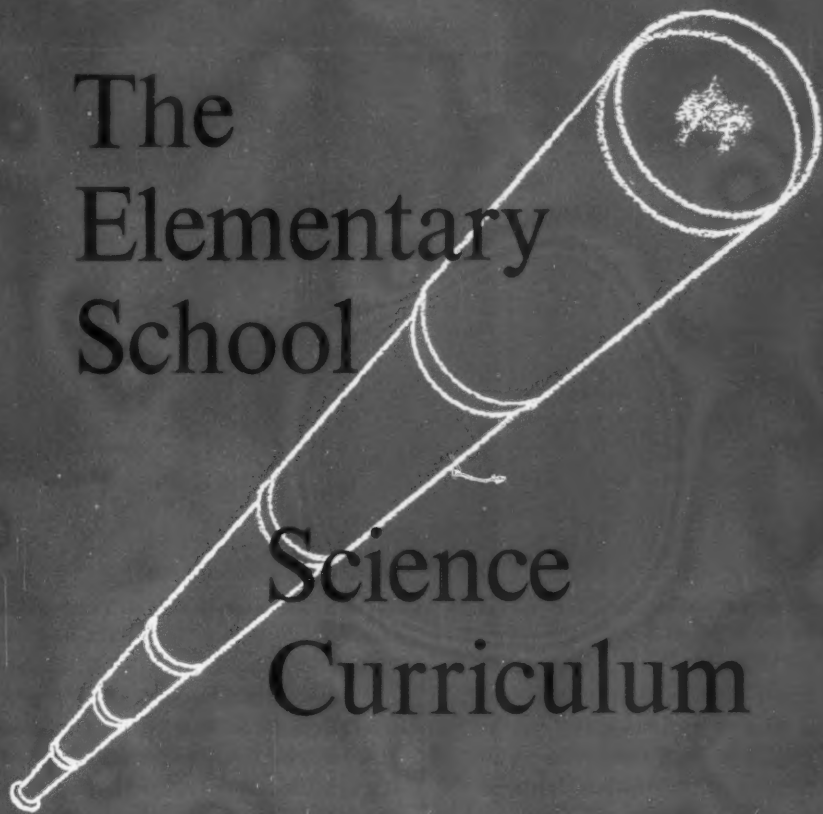
TITLE

PROFESSIONAL ADDRESS

.....

BAUSCH & LOMB

SINCE 1853



The Elementary School Science Curriculum

By J. MYRON ATKIN

College of Education, University of Illinois, Urbana, Illinois

THE elementary school science curriculum in most American schools today is based on a pioneering study reported by Craig in 1927.¹ The results of this study have served us well for over thirty years. But the inevitable questions must now be asked: Is the curriculum appropriate today? Are basic revisions necessary? Is it satisfactory to retain the essential structure of this curriculum and make only those minor modifications demanded by new science knowledge?

Craig's study was, in part, a reaction to some of the excesses of science teaching dominant during the first quarter of the century. But it was also firmly grounded in an educational viewpoint then crystallizing at Teachers College, Columbia University. The in-

creasing body of knowledge about children, their growth and behavior had certain clear implications for building a new curriculum. The child himself was studied intensively, and the results of these studies pointed toward new instructional approaches in school. Education for living: Start at the level of the child and build a curriculum considering his psychological and biological stage of development. What do children want to know? What do they need to know to comprehend the world that impinges on them daily? How should cultural factors influence the curriculum? These are some of the issues that were beginning to demand attention from educators.

To construct his course of study, Craig identified four criteria for building a science program. The program should (1) "greatly influence the thought reaction of the individual," (2) reflect content which has "modified thinking in many fields," (3) help to

establish "health, economy, and safety in private and public life," and (4) reflect content "essential to the interpretation of the natural phenomena which commonly challenge children." By identifying these criteria, Craig helped to give a rational structure to a science program at the elementary school level, a structure that was loose at best prior to 1927.

Craig used three primary sources to construct the science curriculum: the interests of children as reflected by their questions, the opinions of laymen, and certain standard college science texts. The result was a course of study that stressed heavily the influence of science on daily life. Those phenomena which seemed to loom large in the lives of youngsters and adults and which were rooted in science as identified in college texts of the period constituted the curriculum. Topics included electric motors, circuits, description of certain weather phenomena, rock identification, and the economic uses of plants, among many others. A glance at the Course of Study reveals an attempt to cover a broad range of topics in geology, astronomy, biology, meteorology, physics, and chemistry. Craig placed greatest emphasis on his criteria (3) and (4) in selecting content.

Subsequent investigators have turned considerable attention to Craig's first criterion, that of "greatly influencing the thought reaction of the individual." This attention has taken the form of a plethora of writing about scientific method, critical thinking, and problem-solving ability. While there is considerable agreement in the field today that the improvement of children's thinking is a primary goal of science education, very little effort in the field of education bearing on this subject over the past twenty years may be termed research. Attempts have been made to describe problem solving, scientific method, and critical thinking, but comprehensive research programs to discover how such thinking develops and is nurtured through *formal school subjects* are yet to be reported. There has been no basic change in elementary school science curricula in over the past thirty years.

Curriculum Revision

What are the implications for the current spurt of activity, all of it sorely needed and much of it brilliant, on

¹Gerald S. Craig. *Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School*. Bureau of Publications, Teachers College, Columbia University, New York. 1927.

elementary school science programs? First, it can be recognized at the outset that much of the criticism of high school curricula applies to elementary school science programs with equal force. We now cover a large amount of superficial teaching-about-science in the elementary school. The stress is still on applications of science, science in daily living (science in cooking, science in health, science in toys, science in today's refrigerators, etc.). Rarely, very rarely, are children encouraged to probe to some depth in a scientific discipline to appreciate something of its rationale and inner consistency. Rarely are children helped to go beyond the descriptive (nine planets move around the sun; Mars has two natural satellites; shots protect against certain diseases). For most elementary school science teaching, books at the descriptive level are the only books available.

A second weakness in elementary school curricula is one that threatens to weigh down the entire structure. A curriculum in science built on children's interests and the applications of science must grow geometrically in this day and

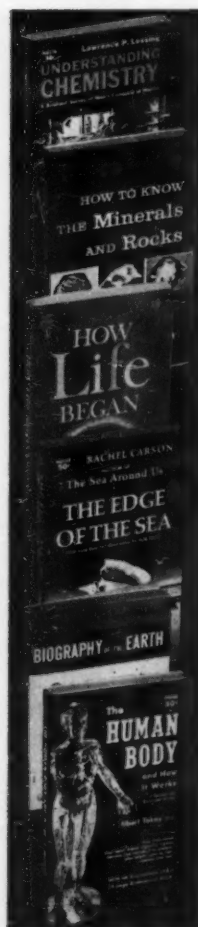


Restructuring the science curriculum to include new content and capture interest requires constant evaluation.

age. Each new technological advance breeds more technological advances. How does one pick from this wealth of achievement that which should be taught to the very young?

Pruning thus becomes a top priority operation in restructuring the elementary school science curriculum. It is impossible to add new content to the already bulging science program without subtracting something. New types of immunization, new surgical techniques, new artificial satellites are all events that are beginning to crowd one another off the front page. The teacher who tries to teach this current content in addition to the already prescribed science work in anything but a cursory fashion is lost. Each new development reveals the teacher's own lack of preparation. Each frantic effort to keep pace with technology clutters curriculum content even further. What content can we afford to drop? What are some reasonable criteria for selecting that which we take time to teach?

The underlying viewpoint of the major secondary school curriculum reform movements in evidence today holds that the major criterion to be used in selection of course content should be to choose that subject matter which is fundamental to the discipline as the discipline is viewed by those with its most penetrating grasp. The man to go to in selecting content for high school physics is the man steeped in the subject, the man who knows it deeply and broadly; in short, the man recognized by physicists as a productive authority. It is probable that most curriculum reform movements in the field of elementary school science



The best bargains in science books...

MENTOR & SIGNET KEY BOOKS

35¢ • 50¢ • 75¢

UNDERSTANDING CHEMISTRY

L. P. Lessing MD276, 50¢

HOW LIFE BEGAN

Irving Adler Ks369, 35¢

THE EDGE OF THE SEA

Rachel Carson MD242, 50¢

THE HUMAN BODY AND HOW IT WORKS

Elbert Tokay KD355, 50¢

THE WEB OF LIFE

John H. Storer Ks333, 35¢

BIOGRAPHY OF THE EARTH

George Gamow MD138, 50¢

HOW TO KNOW THE MINERALS AND ROCKS

Richard M. Pearl KD346, 50¢

THE UNIVERSE AND DR. EINSTEIN

Lincoln Barnett MD231, 50¢

This is a short sampling of over fifty Mentor and Signet Key titles on the AAAS-approved list of inexpensive science books. Write for our science list and complete catalog.

Coming...

THE OSCILLATING UNIVERSE, E. J. Opik (Apr.)

MD289, 50¢

AND THERE WAS LIGHT, Rudolph Thiel (May)

MT290, 75¢

Box SCI-4, THE NEW AMERICAN LIBRARY

501 Madison Avenue

New York 22, N. Y.

will have the same flavor. Thus the desired pruning is accomplished initially on the basis of subject matter considerations. On the surface at least applications of science and children's immediate interests assume a minor role in selection of content. As criteria for a pruning operation, the new emphasis seems reasonable. What might it look like in practice?

Take elementary school astronomy as an example. In this field, the writer, together with Professor Stanley P. Wyatt of the University of Illinois Astronomy Department, has been conducting an investigation with youngsters in the intermediate grades designed to effect pruning based initially on subject matter considerations.

An examination of elementary school textbooks and trade books in the field of astronomy currently available to teachers of elementary school children reveals an almost exclusive emphasis on the solar system. However, though the solar system is discussed at length, the stress is placed entirely on its descriptive aspects. Children are taught the number of planets, their relative sizes, their distances from the sun, and the number of moons revolving around each one. There is also some description of what we know about the surface of Venus, Mars, and Jupiter. In most books certain constellations are identified. Eclipses are discussed, and seasonal change is stressed. The youngster is also subjected to considerable information about the distances between various objects in the solar system.

This content for elementary school astronomy may be criticized on several grounds.

1. The child is given virtually no understanding of how scientists have arrived at the factual material presented in the children's books.
2. The child is given virtually no comprehension of the structure of our own galaxy of stars or of the physical universe and its component galaxies.
3. The child learns in only a cursory fashion of some of the forces at work in this physical system.

With regard to point (1) above, people cannot learn the basic ideas in astronomy without an understanding of how we arrive at astronomical knowledge. What types of observation are important to astronomers and why? What are theories? How do scientists build

them? Even if children studied the solar system exclusively, they can learn much more about astronomy by tracing some of the historical developments with regard to man's conception of the motion of bodies within this system than by reading the books currently available to them.

With regard to points (2) and (3) above, much more could be done with elementary school children to point up concepts related to gravitation; the nature of matter and radiation; the age, origin, and evolution of the solar system, of stars, and of galaxies. These concepts reflect some of the basic concerns of modern astronomers, yet little attempt has been made to teach these concepts at the elementary school level.

Research is needed to bring elementary school science curricula in consonance with the enormous amount of astronomy that has been learned in the last two or three decades and its major methods and problems today. And in so doing, such research should point out possibilities of how younger children may learn astronomy in depth.

The starting point in this investigation was at the level of the professional astronomer. Wyatt studied the textbooks and trade books currently available to elementary school children

in the field of astronomy and outlined several topics that are of vital importance in the discipline but which receive scant attention in the instructional materials for young people. Gravitation, radiation, statistical inference, problems of vast distances and age, problems of origin, and radio astronomy are a few of the neglected modern ideas deserving greater emphasis particularly in the context of the structure of the physical universe as an entity.

With one group in the pilot project, a historical view of the development of man's conception of the solar system was developed. Children were made responsible for devising a view of the solar system based on evidence available to ancient and medieval astronomers. Fourth-grade youngsters showed the ability to conceptualize a scheme of epicycles to describe retrograde motion of the planets. By stressing this topic with the youngsters, the investigators were somewhat successful in the general aim of helping children to realize some of the problems astronomers actually have. In using an inductive approach it is felt that children were helped to see astronomy as a field characterized by problems that challenge the intellect. Further, the youngsters developed a greater appreciation

In directing a science experiment, how much is the child encouraged to probe deeply into the scientific discipline? Does the teacher influence the thought processes?

DEARBORN PUBLIC SCHOOLS, MICHIGAN



for the Copernican Revolution when they themselves had to develop a system that accounted for retrograde motion assuming a heliocentric view of the solar system.

With other groups of children considerable attention was given to the problem of measuring relatively short distances in space by triangulation. Again, the feeling has been in this project that the measurement of distances in space is a much more important notion than merely knowing the distances that are thus measured.

Another experimental group has been concerned primarily with certain basic physical concepts such as mass, inertia, and momentum.

A high degree of success characterized the initial and spotted efforts to teach this "new" content to elementary school children. Children in grades 4, 5, and 6 can and do learn many of the concepts outlined above. Further, children's interests have been consistently high, and parents report that the youngsters take the science problems home for further discussion. So far, however, the investigators have worked

solely with intellectually gifted children, and this writer has been the only teacher working with the children. Several questions arise:

1. Is this basic approach appropriate for all fields of science?
2. Will this approach prove effective with children of average and below average intelligence?
3. Can teachers in the self-contained classroom (who now do the science teaching) handle this content?
4. How does one translate the curriculum reform movements from the experimental and relatively tightly controlled setting to general classroom practice?
5. The most basic question: Is this the content that should be stressed?

No doubt there will be much attention in the next decade to these broad questions. No doubt new fundamental questions will arise that are difficult at present to articulate. But it seems a certainty that funds on an impressive scale will be funneled into elementary school science curriculum reform during the next few years. Partly because of the large sums invested, it is probable that change will be effected at a

much more accelerated rate than has been characteristic in the elementary school science field in the past. A faster rate of change demands (1) involvement and/or (2) careful systematic evaluation in the earliest stages of the new projects by those who have been identified professionally with the field of elementary school science and who hold strong views about the aims and objectives of early science learnings.

In keeping with the trend to make articles in educational journals constructive, this writer feels that the curriculum reform as outlined holds considerable hope for building elementary school science programs that improve children's thinking, yet use the exciting vehicle of modern scientific concepts. At its best, such reform results in teaching what is intellectually challenging, flexible, open-ended, and heuristic. The by-products of such curriculum reform movements (cooperation between people in the fields of science and education) seem as promising for continued progress as the published results of the reform movements themselves.

elementary teachers nationwide are exuberant about the new

SINGER SCIENCE SERIES

**FOR GRADES 1-6
COPYRIGHT 1959**

**FRASIER
MacCRACKEN
DECKER**

An activity program alive with the drama of the IGY and the romance of space exploration

Scientific concepts from five major areas of science are taught spirally in fresh new ways

Problem-solving approach . . . hundreds of activities and experiments

Invigorating child motivation

A teacher's guide which reproduces each page of the text and gives plain "show-how" of teaching lessons and carrying out activities as never before

Part of a complete series of SINGER SCIENCE Textbooks for Grades 1-9

THE L. W. SINGER COMPANY, INC.
Dept. 92, Syracuse 2, New York

NEW DEVELOPMENTS IN HIGH SCHOOL SCIENCE TEACHING

Report of an NSTA Staff Study

WHAT should be the content of an advanced physics course? How many hours should be allotted for laboratory work in chemistry? What science should be taught in the ninth grade? Suggested answers to these and many other questions are to be found in the National Science Teachers Association's recent publication, *New Developments in High School Science Teaching*. (Price \$1.50)

New courses, programs, and administrative procedures from school systems across the country have been described in this 108-page report. In addition, references have been made in it to over one hundred developments and to several major curriculum-planning projects now under way.

This publication is based on a descriptive study of science programs in grades 7-12 in all parts of the United States. It reveals several general trends which cut across subject matter lines.

1. Many new administrative procedures have been established for extending the school program to out-of-school hours and for enlisting the cooperation of college, community, industry, and government groups.
2. The new science courses have greater academic rigor than standard ones.
3. The seminar is a new development for teaching discovery methods and cutting across subject matter lines.
4. Ability grouping is increasing.

Within the framework of these current trends changes can be seen in the various subject matter areas.

In general science there is less reading and talking about science and more of doing it. The amount of laboratory work is increasing and projects are a popular activity. General science courses are being separated from the core program in many schools. Principles of biological and physical science are being stressed in courses designed to lay strong academic foundations for future courses in biology, chemistry, and physics.

Earth-space science is a popular substitute for ninth-grade general science. It combines elements of astronomy, meteorology, and geology in a single course for students of greater than average ability and interest in science.

A majority of the new biology courses are being introduced in the ninth grade, although the tenth grade remains at the level at which the subject is generally given. Biochemical and biophysical aspects of biology are being stressed.

Placing biology in the ninth grade allows for a four-year science sequence. The fourth-year elective might be an advanced course in biology, chemistry, or physics; a specialized course such as microbiology or electronics; or a science seminar.

Physical science courses for academically talented students are also gaining in popularity. Many of these courses combining basic elements of physics and chemistry, are being offered in the tenth grade. There appears to be considerable merit in such courses—greater immediate and delayed retention and greater economy of time. Several patterns of physical

science programs are described in *New Developments in High School Science Teaching*.

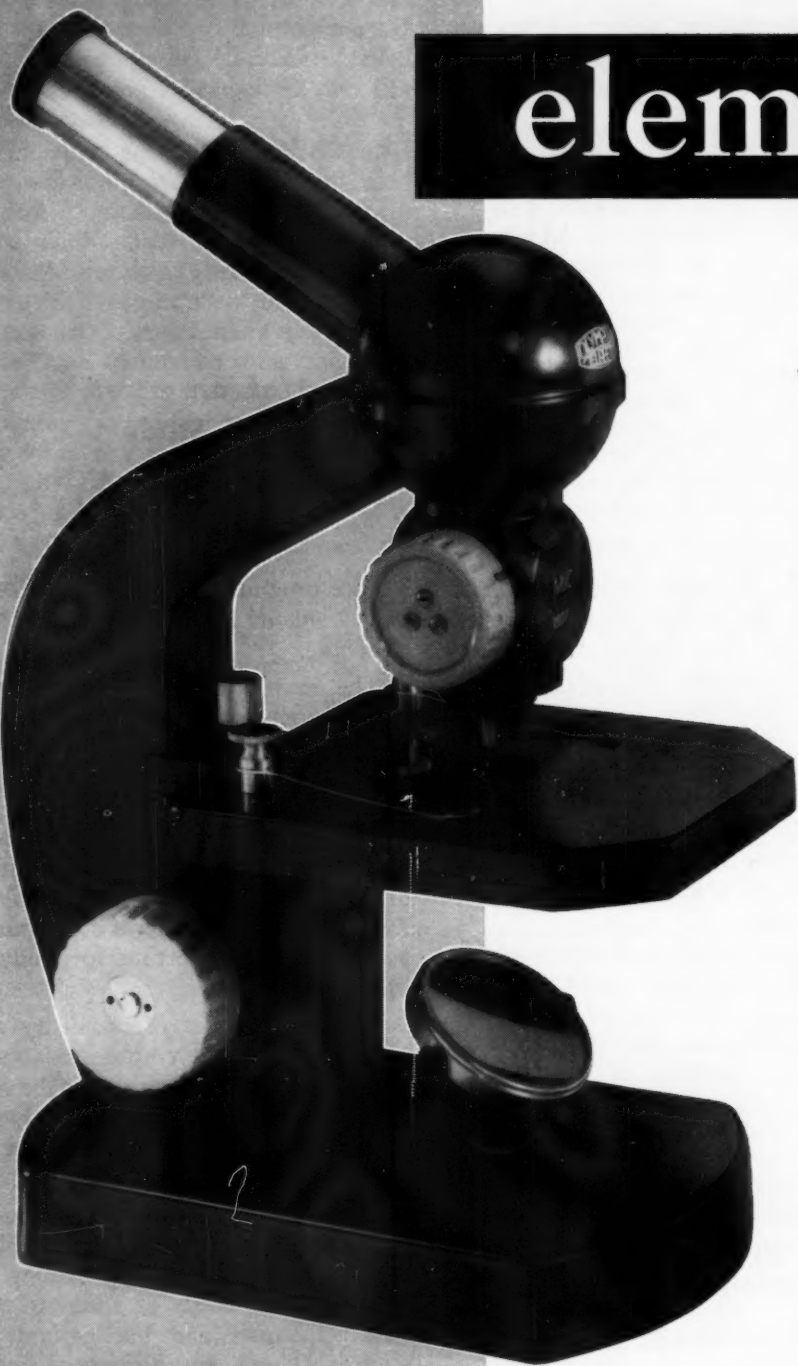
The new advanced chemistry and physics courses tend to stress the study in greater depth of a smaller number of topics. In order to do so it has been necessary to increase the amount of time given to the subject—either in number of hours per week or in number of semesters devoted to the subject. Descriptive materials have been pruned away to allow more time for study of important topics.

The mathematics of chemistry and physics is being emphasized—both through quantitative students in the subjects themselves and through mathematics programs planned to parallel the science programs.

Science seminars have been a popular method of breaking down subject matter boundaries and of providing for the individual needs of students with varied interests and backgrounds in science. There are almost as many variations as there are seminars. A number of representative ones are described in *New Developments in High School Science Teaching*.

In many places the school program has been expanded by use of out-of-school hours and of non-school personnel and facilities. These administrative innovations include before- and after-school, Saturday, and summer programs; in-service programs for teachers; involvement of college, industry, and government personnel as subject matter specialists; and use of extra-school facilities for teaching purposes.

elementary!



the "MIC"

... positively *not a toy*, but a compact, simplified version of famous Elgeet-Olympus precision microscopes for schools, research and industry.

Only **\$39.75** *each*
complete with case

Elgeet went back to school, via a nation-wide survey, to learn from teachers of elementary science what features they considered most important in a microscope for teaching young pupils. Here they are—and you get them all in the amazing Elgeet-Olympus "MIC" Elementary Student-Teaching Microscope:

- SHARP IMAGE
- SIMPLE OPERATION
- STURDY CONSTRUCTION
- SENSIBLE PRICE

Elgeet
of Rochester



10 DAY FREE TRIAL • WRITE DEPT. E-2 • IMMEDIATE DELIVERY

Elgeet OPTICAL CO., INC. . . . SCIENTIFIC INSTRUMENT AND APPARATUS DIVISION
838 SMITH STREET • ROCHESTER 6, NEW YORK

"Quality is our watchword... Precision Engineering our constant goal"

Convention Capsules . . .



Local, national, and international personalities will be leaders in forging the future course of science education at NSTA's Eighth National Convention in Kansas City, Missouri, March 29–April 2, 1960.

Variety, similarity, diversity, debate, and compromise—none of these will escape from the spectral dispersion of planned sessions and activities. "Prescriptions"—old and new, tried and tested—will be presented by some of the leading "science education physicians" of our times. The date is set, the operation urgent, and some of the treatments prescribed are briefly given here. These promise to be among the most beneficial ever proffered in NSTA history. See you ON COURSE . . . at KANSAS CITY.

J. STANLEY MARSHALL. Professor of Science Education, The Florida State University, Tallahassee, Florida. Speaker at the Tuesday afternoon General Session of the Association for the Education of Teachers in Science. Subject: "The Science Teacher for American Schools and How He Should Be Educated."

K-12



AT



K.C.

JAMES R. WAILES. Associate Professor of Education, University of Colorado, Boulder, Colorado. Concurrent Panels for In-Service and Pre-Service Education, Panel A, Elementary Level: "In-Service Education for K-12 Science Teachers"; Friday morning.

JAMES W. GEBHART. Montana State University, Missoula, Montana. "Here's How I Do It" Expanding the Curriculum Session, Saturday afternoon. Topic: "The Montana Earthquake."



K-12

PHILLIP R. FORDYCE. Oak Park and River Forest High School, Oak Park, Illinois. Member of Panel 8, Concurrent Panels, "Current Curriculum Developments in Biology"; Thursday afternoon.



K.C.



HELEN W. CRAWLEY. Natick High School, Natick, Massachusetts. "Here's How I Do It" Physical Sciences Session, Saturday afternoon. Topic: "Radioactivity Experiments Using Orange Glazed Ceramics."

AT

IRVING P. KRICK. Weather Associates, Inc., Denver, Colorado. Speaker, Group 1, Current Developments in Selected Science Areas. Topic: "Man's Conquest of the Weather." Friday afternoon.



K.C.



K-12

JAMES WEIGAND. Science Consultant, Office of the Superintendent of Public Instruction, Springfield, Illinois. "Here's How I Do It" Elementary School Science Session. Friday afternoon. Topic: "Eye-Catching Demonstrations."



MATTHEW F. VESSEL. Chairman, Science Education Department, San Jose State College, San Jose, California. Concurrent Panels for In-Service and Pre-Service Education, Panel A, Elementary Level: "Pre-Service Education for K-12 Science Teachers"; Friday morning.



HUGH ALLEN, JR. Associate Professor of Science Education and Physics, Montclair State College, Upper Montclair, New Jersey; Editor of Convention Proceedings. Presiding, General Meeting for Chairmen and Recorders, Wednesday afternoon.



HAROLD L. BODA. Assistant Superintendent, Dayton, Ohio Public Schools. Featured speaker, Supervisors' Luncheon, Tuesday. Topic: "Role of the Supervisor in Developing Values in the Curriculum."



ROBERT A. BULLINGTON. Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois. Chairman of NSTA's Science Teaching Materials Review Committee, Dr. Bullington will have four film showings with several films from each area as follows: Wednesday morning, "Science in the Laboratory." Thursday morning, "Biological Science." Friday morning, "Space Exploration." Saturday morning, "Conservation."



MILDRED T. BALLOU. Elementary Science Teacher, Station KDPS-TV, Des Moines, Iowa Public Schools. Co-chairman of the General Program Committee; Presiding, First General Session, Wednesday afternoon. Subject: "The Ecology of the Educational Community."



GEORGE E. MATHES. Director of Science, Denver, Colorado Public Schools. Presiding at the K-12 Curriculum Center and Consultant Service, Thursday afternoon and Saturday morning.

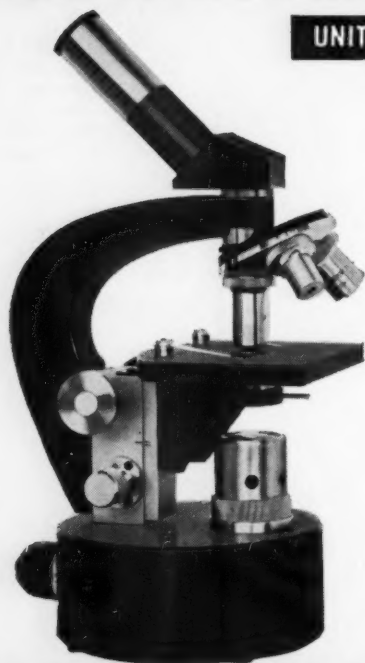


A. NEAL SHEDD. Specialist for Science Clubs, U. S. Office of Education, Washington, D. C. Supervisors' Section, Round-Table Discussions, Group C: "State Supervisors and Consultants in Science"; Wednesday morning.



KATE BELL. Assistant Director of Elementary Education, Houston Independent School District, Houston, Texas. Concurrent Panels for In-Service and Pre-Service Education. Chairman, Panel B, Intermediate Level: "Pre-Service Education for K-12 Science Teachers." Friday afternoon.

UNITRON student microscopes offer



UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory sub-stage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of
25 or more . . . \$94.16 only **\$107**

UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; plano-concave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of
25 or more \$66 60 only **\$74**



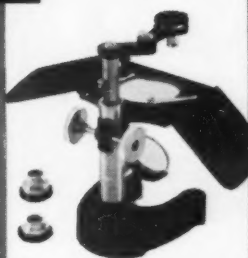
unexcelled quality at budget prices

UNITRON DISSECTING ADS

Heavy base, micrometric rack and pinion focusing, arm rests, mirror and background plate, large glass stage plate, Steinheil magnifiers.

ADS: for 10X, 20X
\$3250

ADSA: for 5X, 10X, 20X
\$3650



UNITRON PHASE MPEA

The first student phase model ever to be offered. Observe protozoa, plankton, etc. in the living state without chemical staining. Objectives: 4X, P10X, P40X. Eyepieces: 8X, 15X. Condenser and phase diaphragm. Write for a reprint of Professor Corrington's article on this remarkable instrument.

MPEA.....**\$99**
(f.o.b. Boston)



UNITRON STEREOSCOPIC MSL

A wide field, binocular, 3-D dissecting model. Diopter and interpupillary adjustments. Removable glass stage plate. One set of eyepieces for 10X, 20X or 30X included; others available at extra cost.

Model MSL.....**\$110**
(f.o.b. Boston)



UNITRON PHOTOMICROGRAPHY SET

Duplicates the performance of costly apparatus. Fits any standard microscope. Mounting brackets adjust for your camera. Viewing telescope allows focusing and selection of field while the camera is in position.

Model ACA...**\$3995**



UNITRON LABORATORY MLEB

Uses the same large, heavy stand as our research models. Three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X. Coarse and fine focusing. Condenser and iris diaphragm. Filter holder and filter. Mechanical stage available.

MLEB.....**\$118**



ACCEPT A FREE 10 DAY TRIAL

We invite you to try any UNITRON Microscope in your own classroom for 10 days at absolutely no cost or obligation. Let our instruments prove their value and quality to you, before you decide to purchase. You will see for yourself why UNITRON is the choice of America's leading universities, schools, and industrial laboratories.

THIS COMPLETE CATALOG ON UNITRON MICROSCOPES IS YOURS FOR THE ASKING!

Gives complete information on the UNITRON Models described above as well as on many others for all types of microscopy. You will find this informative publication a valuable addition to your files.

QUANTITY DISCOUNTS AVAILABLE ON ALL MODELS

Prices include wooden cabinet, plastic dustcover, and free delivery to your school unless otherwise noted.



UNITRON

INSTRUMENT DIVISION OF
UNITED SCIENTIFIC CO.
204-206 Milk Street • Boston 9, Mass.

Please send me your complete catalog on
UNITRON Microscopes 8-A.

Name and Title _____
School or College _____
Address _____
City _____ State _____



Don't Shortchange The Student!

The school and college laboratory is the training ground for budding scientists. It is in school that they learn the fundamentals which they carry throughout their entire lives. It is in school that they formulate the thought processes which they put to good use in the years following graduation.

Because of the importance of this training, no school or college will offer students an inferior textbook or an incompetent instructor. The best is none too good for the scientist of tomorrow!

Similarly . . . the best in laboratory equipment is none too good for today's scientific student. Unfortunately, there is available in this field, laboratory glassware which is known as the "second", or "school" grade of well-known manufacturers.

Don't cheat your students of the opportunity to work with the best available laboratory glassware . . . especially when you can buy it cheaper than some of the "inferior" grades. Specify Diamond D and be sure of the best. For the complete story of Diamond D manufacture write today for our booklet "Behind The Diamond D" Doerr Glass Company, Vineland, N.J.



OL' NANTUCKET WEATHER GLASS

Here is a hand-blown replica of the weather glasses used on the square-rigged sailing ships that rounded Nantucket Light more than a century ago. It is a crystal-clear pear-shaped pendant which hangs on a 10 1/4" long wrought iron bracket. Fill the glass with water according to directions; chart shows how to translate movement of water in spout in terms of weather forecasts. Ideal for home, office, den, recreation room, college dorm or classroom. \$3.95 postpaid. Doerr Glass Specialties, Inc., Vineland, N.J. Offer good only in continental U.S. and Canada.

Diamond D Laboratory Glassware

Quality Begins With Price And Ends With Performance



Self-Raising Weights on Pulley Systems

By WALTER EISENBERG, Weequahic High School, Newark, New Jersey

The conventional treatment of problems involving pulley systems in high school and college texts seems to leave a serious misunderstanding that appears to be widespread. It is therefore felt important that a word be said to teachers of this subject to prevent future errors in this field.

The textbooks speak of an acting force raising an independent resisting weight; most of them say nothing at all about a force raising its own weight as resistance. Because there is no mention of the latter case, it is often erroneously concluded by the reader that both cases would be worked out the same way. For example, with the single fixed pulley it is shown that it takes a force of more than 150 pounds to raise a weight of 150 pounds, if friction is small. Since nothing is said about a force raising its own weight, it is usually concluded that

if a person weighs 150 pounds and tries to raise himself by means of a single fixed pulley, he will have to exert a force of a little more than 150 pounds. In this case, however, the force is just slightly more than 75 pounds. (See Figure 1.)

This comes as a surprise to many students (and some teachers) and is often challenged for proof of correctness. The author has found it a fascinating experiment to allow the challengers to raise themselves on a single fixed pulley system and see by experience that it takes a force of only one-half their weight. The actual experience

is worth the effort of setting up the experiment for students.

In offering a theoretical proof for this observation a variety of approaches may be used. It may be shown that if a person raises himself ten feet into the air, twenty feet of rope will have passed through his hands, thus requiring a force of one-half the weight. It may also be shown that as soon as a person takes hold of the free strand, it becomes one of the strands supporting the weight, and the system in effect has become a two-strand pulley system. Other proofs follow along these same lines.

Once the single fixed pulley problem

Classroom

IDEAS

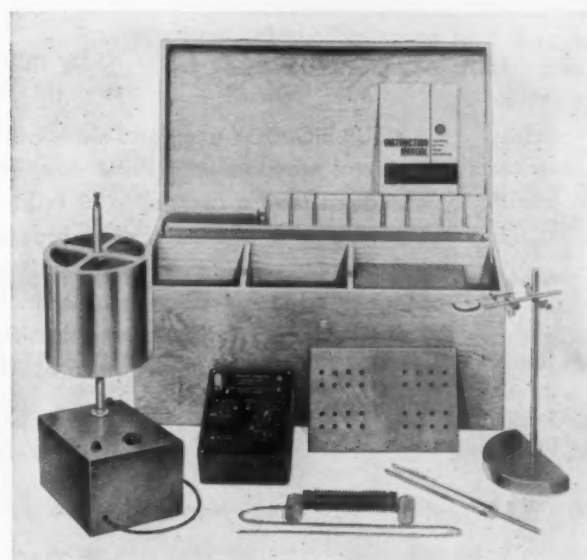


TEACHING KITS FOR STUDENT PHYSIOLOGY EXPERIMENTS

Many physiological phenomena can be translated into motion. In order to best demonstrate these phenomena in the classroom, it is possible to make a continuous and permanent record of this motion which can be discussed during and after the experiment. The Harvard Apparatus Teaching Kits are built around a recording device. In the case of the standard Kit #1000, the device is an electric kymograph, one of the simplest recording instruments to operate and maintain. It produces a wide range of recording speeds and is useful in the majority of experiments. Also available are many levers which will show and record motions of all kinds, such as the contraction of frog muscle resulting from electrical stimuli. The induction stimulator provides electrical stimuli and time marking signals. Human as well as animal phenomena can be shown. For example, the pneumograph demonstrates breathing patterns, and the plethysmograph can be used to show the volume pulse.

Special kits containing equipment and supplies other than those listed for the standard Kit #1000 can be made to order. In all cases, the cost will be a total of list prices. We invite you to send for our Catalog 1959-60 and new price list which contain our complete line of recording instruments and accessories, circulation and respiration equipment, electrical equipment, clamps, stands, rods and various animal accessories. Also available on request is a detailed data sheet listing the contents of the standard Kit #1000 plus a range of auxiliary equipment.

Harvard Apparatus Company, Inc., a non-profit organization, seeks to promote better science teaching through the manufacture of superior physiological apparatus made available at the lowest possible cost. All apparatus is of the highest quality and will give years of continuous service.



CONTENTS OF THE STANDARD KIT #1000 (illustrated)

Electric Kymograph	Plethysmograph Tube
Kymograph Paper	Pneumograph
Induction Stimulator	Clamps
Flat Base Stand	Colophonium Cement
Muscle and Heart Levers	27mm. Signal Magnet
Small Scale Pan	Frog Board (with clips)
10g. Weights	Tuning Fork and Starter
Marey Tambour	Stylus
Silver Electrode	Fitted Case, 24" x 12" x 12"
	\$198.00—f.o.b. Dover, Mass.



HARVARD APPARATUS CO., INC. • Dover, Mass., U. S. A.
(a non-profit organization)

*Understanding
takes
time*

YOUR BIOLOGY

by Ella Thea Smith and
Lorenzo Lisonbee. Accom-
panied by manual (with
tests)

THE PHYSICAL WORLD:

A COURSE IN PHYSICAL SCIENCE

by Richard Brinckerhoff,
Burnett Cross, Fletcher
Watson, and Paul F.
Brandwein. Accompanied
by manual and tests.

YOUR BIOLOGY integrates many activities and illustrations with the text to give students several ways to understand one idea. For example, to begin a section on tissues, students read a description of cells, see side-by-side comparisons of cell drawings and photographs, and do a microscope activity on cells. THE PHYSICAL WORLD discusses thoroughly one idea—in fields such as chemistry, mechanics, and wave theory—before presenting it in greater detail or as an equation. For instance, Ohm's Law is discussed first in clear verbal terms and then stated as a verbal equation. Both books are written specially for students who need opportunity and time to understand.

Understanding takes time

. . . and time is taken by YOUR BIOLOGY
and THE PHYSICAL WORLD



HARCOURT, BRACE AND COMPANY New York
Chicago - Dallas - Burlingame

is clearly understood, it is easy to show the same principle as it applies to the various types of movable pulley systems. When a painter raises himself on a scaffold and four strands support the movable pulley, the so-called free strand he has in his hand is also to be

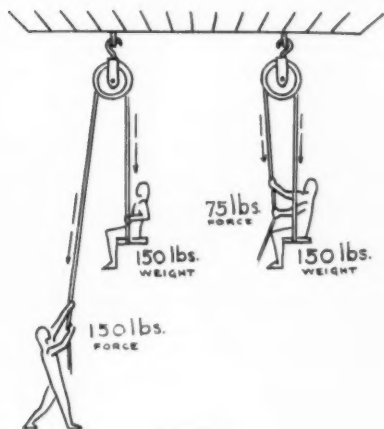


FIGURE 1.

considered as supporting the weight, and the mechanical advantage used in this problem would be five instead of four. The addition of one to the usual mechanical advantage would be applied in all problems of this kind.

Because some textbooks in current use have the wrong answer given in problems of this type, it would be well to check all books and notify each author where such error exists.

Physics

Experiment 1 Velocity of Sound in Air by Resonance (Determination of the End Correction)

By JULIUS SUMNER MILLER, El Camino College, El Camino College, California

The usual laboratory method for determining the velocity of sound in air by resonance is well known. A vibrating tuning fork is held over an air column whose length is conveniently varied by changing the height of a water column in it. The theory shows that the first resonant length is approximately one-quarter of the wave length; $L_0 = \lambda/4$. This is corrected by adding to L_0 six-tenths of the radius of the tube. Then, $V = 4fL$, where L is the



As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to TST's calendar editor as early as possible.

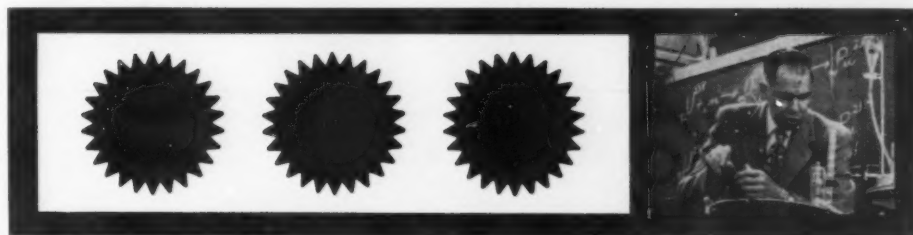
March 29-April 2, 1960: NSTA Eighth National Convention, Muehlebach and Phillips Hotels, Kansas City, Missouri

June 29, 1960: NSTA Annual Summer Meeting with National Education Association, Los Angeles, California; Luncheon meeting and afternoon session

June 29-July 1, 1960: Annual Business Meeting of Board of Directors, Los Angeles, California

September 9-10, 1960: NSTA Regional Conference, University of North Carolina, Chapel Hill

October 28-30, 1960: NSTA Regional Conference, Deauville Hotel, Miami Beach, Florida



An Opportunity to Bring a Nobel Prize-Winning Scientist Into Your Classroom . . .

Your students can now see and hear Dr. Glenn T. Seaborg and his associates as they describe the dramatic discoveries of missing and transuranium elements in a series of three **FILMS** entitled **THE ELEMENTS**.

*Titles In The Series

MODERN ALCHEMY / Dr. Seaborg describes the isolation and identification of the four "missing elements," francium, technetium, astatine, and promethium.

BEYOND URANIUM / Dr. Seaborg outlines the discovery of the first six elements beyond uranium.

MAKING ELEMENTS / The scientists who participated in the discovery of elements 99, 100, and 101 describe and demonstrate the techniques, equipment, and chemistry associated with the original isolation of these elements.

EACH FILM—16mm / 30 minutes / B&W / \$125

*These films qualify for purchase under Title III of the National Defense Education Act.

Send For Free Information!

Preview Prints Available

NET Film Service
Indiana University
Bloomington, Indiana
Please send information about

THE ELEMENTS films to:

Name _____
Organization _____
Address _____
City _____ Zone _____ State _____



LOW-PRICE CLASSROOM AIDS for SCIENCE TEACHERS

Write for FREE CATALOG "AC"



GIANT MAGNET! 5 lb. Size! WAR SURPLUS—ALNICO V TYPE

A real bargain opportunity. A - 3 1/4"; B - 2 3/4"; C - 4-3/16"; D - 1 1/4"; E - 1 1/4"; F - 2 3/8". Strength is about 2,000 Gauss. Will lift over 125 lbs.

Stock No. 70,183-AC, 5 lb. size.....\$8.50 Postpaid

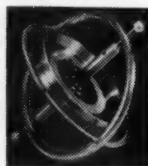
15-3/4 lb. size. Approximately 5,000-6,000 Gauss rating. Will lift over 250 lbs.

Stock No. 85,088-AC, 15 3/4 lb. size.....\$22.50 F.O.B.

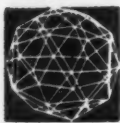
Shipping wt. 22 lbs. Barrington, N. J.

GIANT GYROSCOPE TOP

Sturdy 4" diameter instrument is ideal for classroom or amateur physical experiments in demonstrating the principles of rotation, attraction and equilibrium of moving bodies, centrifugal forces, centripetal forces. Metal stand, booklet, FUN WITH GYROS and instructions included.



Stock No. 50,224-AC.....\$4.95 Postpaid



D-STIX CONSTRUCTION KITS

Visualize Ideas Fast!

Newest, handiest visualizing and demonstration tool for teachers elementary, high school or college. Colored wood sticks 1/8" thick and "easy-on" rubber joints approx. 3/16" diam. fit together quickly to form all kinds of simple or complex shapes, structures. Ideal for teaching mathematics, chemistry, physics, design, engineering, architecture, abstract art—or for developing children's interest in form and structure. Work out geometric figures, molecular structures, structural members, configurations and perspectives, models of many types. 3-dimensional visualization adds interest—speeds understanding. Used by professional planners, designers, architects. Money-back guarantee.

Stock No. 70,209-AC (230 pcs).....\$3.00 ppd.

Stock No. 70,210-AC (370 pcs).....\$5.00 ppd.

Stock No. 70,211-AC (452 pcs).....\$7.00 ppd.



STEREO MICROSCOPE

Over 50% Saving. Up to 3" Working Distance—Erect Image—Wide 3 Dimensional Field. Used for inspections, counting, checking, assembling, dissecting. 2 sets of objectives on rotating turret. Standard pair of wide field 10X Kellner Eyepieces give you 23 power and 40 power. Helical rack and pinion focusing. TEN-DAY TRIAL!

Order Stock No. 85-056-AC

Full price.....\$99.50 f.o.b. Barrington, N. J.



LOW-COST VERSATILE SPECTROSCOPE

Ideal for experimental or school uses. Can be used with transmission diffraction grating replica (a piece is supplied) or with prism. It has a rotating prism table with scale. The telescope arm extends through 120°. 10X eyepiece is standard microscope size with reticle. Slit is adjustable. Optical system includes two achromatic 25mm diam. 122 mm f.l. lenses. Arms extend from 5" to 8" for focusing. Diameter of base is 6", overall height 4" and overall width approx. 14". Instructions included.

Stock No. 70,229-AC.....\$39.50 Postpaid

NOTICE: Edmund is now headquarters for Math Learning and Teaching Aids! See dozens of offerings in our FREE Catalog—"AC."

TRIG AND CALCULUS CARDS

Used to clinch the learning of trig identities or calculus formulas. Each deck contains 52 playing cards, plus instruction, and is used to play a game similar to Solitaire. Our decks include Differential Calculus, Integral Calculus, Applied Calculus, and Fundamental Identities from Trig.



Stock No. 40,314-AC—Set of all four decks....\$4.00 Pstpd.

REPLICA GRATING

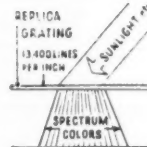
Take Unusual Color Photos At Night!

After decades of effort, low-cost diffraction grating replica film is available. This film has 13,400 lines per inch. Diffraction Grating has been used to answer more questions about the structure of the material world and the universe than any other single device. Use it for making spectroscopes, for experiments, as a fascinating novelty. Cheap enough that you can pass a piece out to each student. Produces beautiful view of spectrum. Comes in clear plastic protector.

Stock No. 50,202-AC—includes 2 pieces 8" x 5 1/2"—

1 transmission type, 1 reflecting type.....\$2.00 Pstpd.

Order by Stock No.—Send Check or M.O. Satisfaction Guaranteed



NEW, LOW-COST LAB PROJECTOR SHOWS EXPERIMENTS ON SCREEN!

New way to teach chemistry and science. Project on-the-spot experiments, on screen or wall, with magnification, actually as they progress. Important phases, reactions may be observed by student group in revealing size—perfect vehicle for clear-cut instruction. Projector comes with a 3-element, 80mm focal length f/3.5 anastigmat lens and a fast 28mm focal length, 4-element f/1.2 lens for microslide projection use. Also you get special elevated slide and specimen projection stage; standard 35mm, 2" x 2" slide carrier; 35mm strip film holder. Additional accessories available—water cooled stage; polarizing filters; petri dishes; miniature test tubes and holders; gas absorption apparatus, electrolytic cells and many others.



Stock No. 70,230-AC.....\$45.00 Postpaid

Separate motor and blower for cooling Projector.

Stock No. 70,263-AC.....\$15.00 Postpaid

LOW FRICTION AIR PUCK

DEMONSTRATES FRICTIONLESS MOTION



This fascinating model will float around on a flat surface on a cushion of air. Just touch it slightly and it will slide frictionlessly across the table, etc. Operates on same principle as Ford's and Curtiss-Wright's new, wheelless air-glide cars. Special balloon provides the air, and base is of strong, flat plastic 5" in diameter.

Stock No. 50,228-AC.....\$2.00 Postpaid

6" Dia. heavy Chromed Steel Puck—operated by fizz bottle cartridges.

Stock No. 70,185-AC.....\$22.50 Postpaid

RIPPLE TANK

Simplifies Teaching of Wave Motion of Light

One-piece, leak-proof tank is made of optically transparent plastic with a clear water area 20" x 20" ... 1 1/4" deep. The rigid wood frame comes in two identical units, the bottom frame receiving the water tank and the upper frame holding a rigid, translucent plastic projection screen. A clear bulb placed beneath the tank provides illumination for projection. Mechanism is actuated by an eccentric fastened directly to the small motor shaft. Wave vibrations are transmitted to the water surface through a leaf spring supported rod, to give parallel wave front or point source agitation with the supplementary attachment which is included. Motor is operated by two flashlight batteries in a brass case with a sturdy rheostat to vary the speed. Order today. Low cost permits purchase in quantity.



Stock No. 85,064-AC.....\$49.50 f.o.b.

(Shipping weight 35 lbs.) Barrington, N. J.

Order by Stock No.—Send Check or M.O. Satisfaction Guaranteed!

FREE CATALOG—AC

128 Pages! Over 1000 Bargains!

America's No. 1 source of supply for low-cost Science Teaching Aids, for experimenters, hobbyists. Complete line of Astronomical Telescope parts and assembled Telescopes. Also huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, satellite scopes, binoculars, infrared sniperscopes, math learning and teaching aids. Request Catalog—AC and FREE Bulletin 50-AC (on Science Teaching Aids).



EDMUND SCIENTIFIC CO.
BARRINGTON, NEW JERSEY

corrected length. Finally, $V = V_0 (T/273)^{1/2}$. It is instructive to determine the end correction experimentally. Two methods are available.

Method 1. Let f be the fork frequency, L_0 the length of the air column, and d the end correction. Then $V = 4f(L_0 + d)$. Use several forks and find the first resonant length for each. Plot L_0 against $1/f$. This is a straight line with a y-intercept of magnitude d . The slope of the graph is also the velocity of sound.

Proof: Write $V/4f = L_0 + d$. This is of the form $y = mx + b$, with intercept $-d$, and slope $V/4$.

Method 2. Use two forks an octave apart. C(256) and C'(512) are good. Let C resonate at L_1 , and C' at L_2 . Then

$$4 \times 256 \times (L_1 + d) = 4 \times 512 \times (L_2 + d)$$

Whence $d = L_1 - 2L_2$.

Experiment 2

Total Energy of Motion of the Earth

The earth revolves about the sun and rotates on its own axis. For this activity there is an enormous amount of energy used. It is interesting to discover how much energy is involved.

Assume the following data, stated approximately:

Mass of the earth (M) 5.0×10^{27} grams (6×10^{21} tons).

Mean radius (r) 6.0×10^8 cm (4000 miles).

Mean distance to the sun (R) 1.5×10^{13} cm (93,000,000 miles).

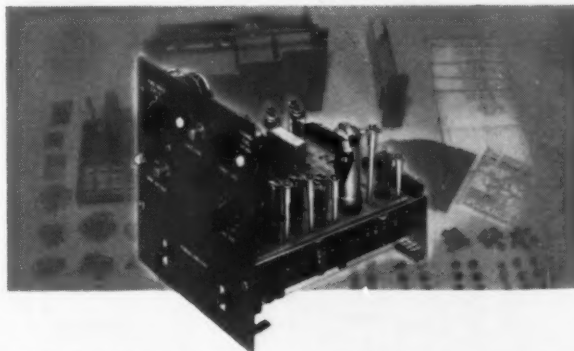
Angular speed of rotation (ω) $2\pi/86,400$ rad/sec.

Angular speed of revolution (Ω) $2\pi/365 \times 86,400$ rad/sec.

The kinetic energy of rotation is $\frac{1}{2} I \omega^2$. Using the data above we find KE_R to be 2×10^{36} ergs. The kinetic energy of translation is $\frac{1}{2} M \Omega^2 R^2$. The data gives us for KE_T 2×10^{40} ergs.

The translational kinetic energy is therefore about 10,000 times the rotational kinetic energy.

What could this energy do? Converting it to heat energy using 4.2×10^7 ergs/calorie, this could melt over 10^{10} cubic miles of ice. Assuming the specific heat of the earth to be about $1/7$ calorie/gram/ $^\circ\text{C}$, this energy could raise the temperature of the whole earth about 150° .



Professional electronic equipment for the classroom:

CAN YOUR SCHOOL AFFORD IT?

If you think the answer is no, you're in for a surprise . . .

Your students deserve the opportunity of working with the best electronics equipment possible. Yet, electronics equipment is complex, and, alas, too often, too expensive.

Is there a solution to this dilemma — this side of a Rockefeller grant?

We're here to tell you there is!

Our idea is simply this: Alden can provide you with professional equipment, the identical equipment now being used by the design engineer in the field, in the form of basic, inexpensive, electronic "kits". Each kit consists of all the necessary basic components with which your students can plan, lay out, mount, house, fasten, and monitor electronic circuitry; planning sheets, terminal cards, hardware, terminals, basic chassis for housing, eyeletting tools — everything is included.

These are the advantages: 1) this is professional equipment, in every way 2) the kits offer limitless flexibility — circuitry can be reassembled repeatedly, in endless configurations, simple or complex 3) additional design tools and components can be added as needed, from our stock 4) these kits are complete — the student starts at the planning stage, follows through to completed equipment 5) the price is reasonable — kits are available at prices ranging from \$11.50 to \$249.50.

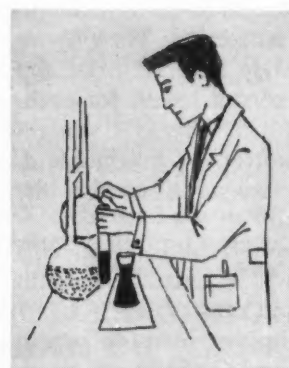
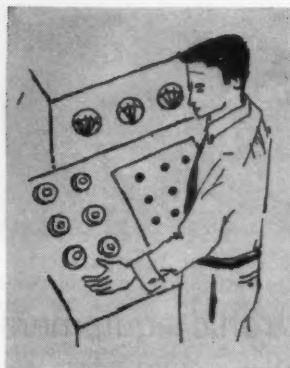
Let us send you complete information. There is no obligation.

ALDEN

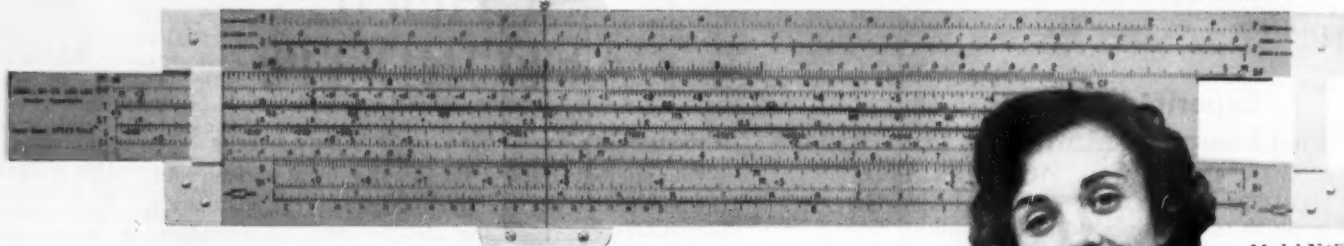
PRODUCTS COMPANY

174 N. Main Street, Brockton, Massachusetts





CAREERS START HERE



With Pickett Slide Rules and FREE Teaching Aids

Don't miss your opportunities in shaping creative scientific careers with exciting new teaching! Pickett provides you with the method—and the tool—in the form of a giant 4-foot Demonstration Slide Rule that you can wall or desk mount for more effective teaching. With it, you get an authoritative instruction manual and a suggested Teaching Outline by Professor Maurice L. Hartung, University of Chicago. These are absolutely FREE. See your school supplier or mail coupon for full particulars. To give your students every advantage tomorrow, send the coupon today!

Pickett All-Metal Slide Rules Feature:

- A model for every course and profession
- Eye-Saver yellow or white color
- Micro-Divided for extreme accuracy
- Slider tension springs
- Functional scale groupings
- Registered lifetime guarantee

***Pickett* SLIDE RULES**
All-American Made



Model N4ES
Vector Type
Log Log
Dual Base
Speed Rule

Pickett & Eckel Co., Inc., 542 S. Dearborn St., Chicago 5, Ill
Gentlemen: 14C

Please send me full particulars of your FREE Demonstration Slide Rule offer with accompanying teaching manuals.

NAME _____

SCHOOL _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

MY TITLE _____



NSTA Activities

Nominees for Board of Directors

As specified in our Constitution, President-Elect Robert A. Rice will become President (NSTA's fifteenth) next July. Candidates for other vacancies to be filled as of June 1 are as follows:

For President-Elect

Dr. J. Darrell Barnard; New York University, New York City.

Mrs. Suan Brown; Public School System, Atlanta, Georgia.

For Secretary

Mrs. Mildred Ballou; Station KDPS-TV, Public School System, Des Moines, Iowa.

Sr. Mary Charlotte; Sisters of Holy Cross High School, Los Angeles, California.

For Regional Directors

II

Dr. Hugh Allen, Jr.; Montclair State College, Upper Montclair, New Jersey.

Mr. Richard S. Smith; Haverford Township Senior High School, Haverstown, Pennsylvania.

IV

Mr. Robert D. Binger; State Department of Education, Tallahassee, Florida.

Mrs. Ruby B. Fitzgerald; Bossier High School, Bossier City, Louisiana.

VI

Dr. Clarence H. Boeck; University of Minnesota, Minneapolis, Minnesota.

Dr. Milton O. Pella; University of Wisconsin, Madison, Wisconsin.

VIII

Mr. Teruo Masatsugu; State Department of Education, Honolulu, Hawaii.

Dr. Donald W. Stotler; Public School System, Portland, Oregon.

Proposed Action for K-12 Program

One of the major items in the 1959-60 program of NSTA has been consideration of a K-12 program for science. This has

now been reviewed by over 2000 persons in conference situations and by questionnaires. It is expected that another 2000 or more individual teachers will have an opportunity to react and help frame Association policy on this item during the convention in Kansas City, Missouri. The proposed action by the Association has been developed in the form of a tentative resolution by the discussion groups which met in Chicago, Illinois during NSTA's annual meeting with the American Association for the Advancement of Science.

"We believe that NSTA could make a contribution to the further development of K-12 science programs in American schools by taking action as follows:

1. Establish a committee (or utilize an existing committee) to study the K-12 science programs that have been developed or are in the process of development in communities across the country. Careful study of these programs would make available to the NSTA the thinking and planning of hundreds, if not thousands, of teachers and other education workers. We have in mind such programs as are in the process of development in New York City; Fairfax County, Virginia; Cincinnati, Ohio; Lexington, Kentucky; Indianapolis, Indiana; and Glendale, California.

The analysis and study of existing K-12 science programs should take into account at least the following important factors:

- a. The different procedures of administrative arrangements characteristic of the programs studied.
- b. The different communities represented in the K-12 programs examined—rural, suburban, city.
- c. Differences and similarities among the stated goals for the K-12 programs.
- d. The policies established or proposed in the various programs for achieving the stated goals; for example, proposed answers to scope and sequence problems and provi-

sions made for taking into account the known individual differences in abilities and interests.

2. During or immediately following the completion of the study indicated above, the committee should explore and formulate tentative goals and policies for developing K-12 science programs looking ahead to realizable achievements over the next ten years.

3. The making of the significant changes in present programs needed to achieve a dynamic K-12 science program in the schools is fundamentally a social process and will require time. Therefore, the tasks suggested above should be prosecuted without delay in order that whatever contribution NSTA may be able to make to the furtherance of the K-12 science program can be initiated within the next two or three years.

4. Finally, we suggest that provisions be worked out for promoting and disseminating the proposals or suggestions developed by the committee through existing and appropriate channels such as the national organizations associated with the principals and the elementary classroom teachers."

Science for Parents of Elementary School Children

Today every parent is concerned with getting Johnnie to "learn" science. All children *can* learn science. And all parents can help in the process if they are properly informed about three things—science, children, and the learning process.

Early next fall NSTA will publish a booklet for parents, focusing on these three points. Dr. Herbert S. Zim, Educational Director of the Golden Press, Inc., publisher of science books for children, will be the author.

Convention Flash!

NSTA will be signally honored at the Kansas City convention through the addition of an eminent British scientist who will join with Dr. George B. Kistiakowsky as banquet speaker on Friday evening, April 1. Through cooperation of the British Embassy in Washington and in recognition of the tercentenary of the Royal Society, we will be privileged to hear an address by Professor Samuel Devons, F.R.S., Langworthy Professor of Physics and Director of the Physical Laboratories, University of Manchester. His address will stress the historical perspective of science and will be an appropriate adjunct to that of Dr. Kistiakowsky, who will emphasize the role of science in effective citizenship today.

BIOCRAFT MICROSCOPES

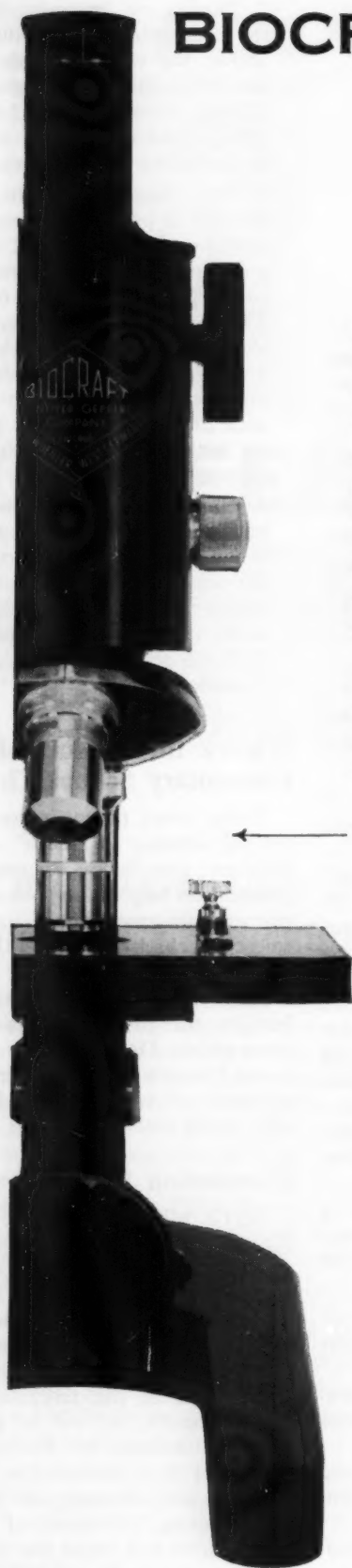
*combine high optical quality
with rugged construction
for long useful life*

Fine optics and durability characterize the new Biocraft microscopes. Equipped with high-resolution achromatic objectives, these instruments provide excellent image clarity, a prerequisite of successful microscope work for beginning student and scientist alike.

Total magnifications of 100X and 450X are achieved on popular model E2 (illustrated left) by 10X and 45X objectives in combination with 10X Huyghenian ocular. Numerical apertures are 0.30 and 0.85, respectively, for the 10X and 45X objectives.

Coarse and fine focusing mechanisms are on separate sets of dovetail slides. Fine adjustment is micrometer-screw and lever type, with a range of over 12 revolutions. Rack and pinion coarse adjustment has stop to prevent slide damage.

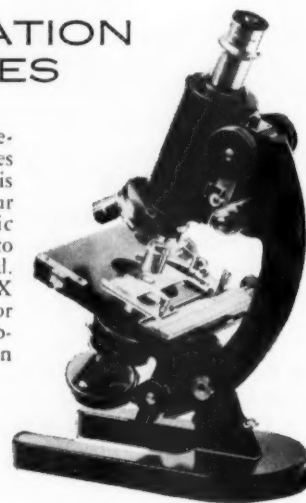
← **MODEL E2** — \$106.20 EACH IN QUANTITIES OF FIVE OR MORE



DEMONSTRATION MICROSCOPES

One of the most frequently selected demonstration microscopes in the extensive Biocraft line is the E6, illustrated right. With four oculars and three achromatic objectives, a range of 17.5X to 2500X magnification is provided. Price includes achromatic 100X objective plus those mentioned for model E2, mechanical stage, sub-stage condenser in rack and pinion mount, and carrying case.

MODEL E6
\$231.30 EACH.
FIVE OR MORE



Complete specifications furnished on request. Ask for circular S59.

DENOYER-GEPPERT
COMPANY

5241 RAVENSWOOD AVENUE

CHICAGO 40, ILLINOIS



FSA



Activities

U. S. Registry—A Progress Report

After many months of planning and collecting statistics of science, mathematics, and language teaching personnel, the 1960 U. S. Registry is now available. As an example of the basic purpose of

gathering such a listing, the first mailing to teachers was the National Science Foundation bulletin on summer programs for secondary students of exceptional science and mathematics ability. The blanketing of the United States with announcements of education opportunities for teachers and students provides a program of enrichment available to all those

who are capable and interested in participating in various activities.

This is the fifth year of registry mailing service to teachers by the National Science Teachers Association. We have cooperated with the National Council of Teachers of Mathematics, the National Science Foundation, and the Modern Language Association of America in making this year's listing the largest ever undertaken. Over 158,000 names with school addresses of science, mathematics, and modern foreign language teachers have been collected and coded on machine cards to facilitate the mailing of current professional information and materials. During these years, the Registry has been made available to educational, professional, and business-industry groups for a nominal fee. In 1959, over 300 mailings went to groups of teachers in various breakdowns of teaching assignments or geographical areas.

Other information obtained in collect-

TABLE I

STATE	SCIENCE							MATHEMATICS				CATEGORY TOTALS			Total of Columns I, II, & III
	General Science	Biology	Chemistry	Physics	Other	*50% or More	Science Dept. Heads	Grades 7-8	Grades 9-12	*50% or More	Math. Dept. Heads	Total Science Only	Total Math. Only	Total Science & Math. Comb.	
ALA.....	1,124	489	343	291	124	745	262	878	911	751	274	1,008	1,002	643	2,653
ALASKA.....	31	28	17	16	6	27	4	24	52	24	7	30	44	29	103
ARIZ.....	168	196	113	93	46	259	70	130	383	285	66	291	357	87	735
ARK.....	503	278	173	114	160	379	183	497	560	493	168	513	660	315	1,488
CALIF.....	1,878	1,350	858	657	917	2,819	686	2,271	4,459	3,514	682	2,825	4,750	1,430	9,005
CANAL ZONE.....															
COLO.....	558	294	204	196	137	502	152	593	698	589	162	601	761	389	1,751
CONN.....	498	314	237	188	131	630	128	373	790	665	138	717	801	333	1,851
DEL.....	115	60	49	42	42	117	22	104	144	130	26	143	155	66	364
D. C.....	116	71	48	34	34	162	38	196	249	219	47	177	302	87	566
FLA.....	1,109	580	320	229	295	1,128	273	1,037	1,213	1,223	256	1,399	1,543	545	3,487
GA.....	749	507	339	270	144	761	220	603	1,006	832	219	949	1,095	480	2,524
GUAM.....	4	1	1	1		5	1		5	5	1	5	3	2	10
HAWAII.....	194	85	51	38	47	179	42	157	247	179	46	223	277	100	600
IDAH.....	202	148	105	91	85	215	62	233	324	277	60	275	349	200	824
ILL.....	1,772	1,258	860	770	347	2,111	533	1,156	2,748	2,198	508	2,604	2,733	1,213	6,550
IND.....	847	800	546	500	209	942	281	1,001	1,498	1,231	302	1,291	1,497	780	3,568
IOWA.....	1,066	665	474	506	255	946	346	945	1,248	1,037	333	1,208	1,335	769	3,312
KANS.....	616	509	362	319	123	515	248	458	890	630	242	704	810	485	1,999
KY.....	525	341	220	154	158	464	142	444	691	528	139	639	702	425	1,766
LA.....	922	508	364	187	194	636	219	765	979	817	205	890	1,040	719	2,649
MAINE.....	243	193	182	154	82	247	109	122	401	255	102	260	312	226	798
MD.....	814	372	233	170	140	794	184	763	872	898	181	848	1,022	476	2,346
MASS.....	1,331	654	551	473	261	1,488	327	1,227	1,994	1,703	327	1,527	2,094	922	2,543
MICH.....	1,781	1,027	748	584	340	1,904	471	2,094	2,401	2,113	458	2,032	2,779	1,414	6,225
MINN.....	1,161	647	502	469	202	1,242	352	1,229	1,429	1,364	341	1,403	1,653	671	3,727
MISS.....	437	273	224	123	153	332	184	440	538	456	202	493	624	277	1,394
MO.....	836	573	383	325	216	719	282	707	1,186	868	270	907	1,179	581	2,667
MONT.....	267	160	118	118	82	249	82	216	326	242	81	212	270	268	750
NEBR.....	440	362	242	266	142	398	190	337	616	449	184	516	540	383	1,439
NEV.....	69	34	21	24	29	55	12	77	88	67	17	63	99	71	233
N. H.....	171	128	115	105	50	222	58	119	296	225	55	222	255	137	614
N. J.....	1,006	662	527	387	225	1,436	290	671	1,753	1,490	284	1,634	1,800	571	4,005
N. M.....	249	190	119	82	52	250	75	255	374	328	68	307	410	187	904
N. Y.....	2,908	1,695	1,383	1,001	1,043	3,737	773	2,564	4,170	3,822	721	4,287	4,848	1,393	10,528
N. C.....	1,304	743	502	398	302	887	359	1,161	1,287	919	306	1,085	1,402	1,061	3,548
N. D.....	282	210	154	118	95	214	122	282	328	236	119	263	324	265	852
OKLA.....	693	471	275	194	153	564	222	733	856	726	258	692	994	428	2,114
OHIO.....	1,911	1,151	946	736	616	2,152	468	1,754	2,654	2,248	448	2,592	2,789	1,336	6,717
ORE.....	444	324	200	142	118	483	122	284	705	496	130	556	652	332	1,540
PA.....	2,409	1,366	1,072	861	593	2,869	587	2,108	3,417	2,984	558	3,569	3,809	1,197	8,575
PUERTO RICO.....	97	85	53	52	16	98	27	79	154	97	22	101	106	120	327
R. I.....	161	77	56	36	23	164	39	166	236	170	37	171	209	169	549
S. C.....	904	352	254	167	86	567	199	705	752	790	186	785	906	501	2,192
S. D.....	265	182	135	121	66	218	115	214	328	221	91	263	266	267	796
TENN.....	632	428	317	211	172	571	207	625	917	731	212	822	1,072	419	2,313
TEXAS.....	1,806	1,338	886	656	628	1,820	598	2,126	2,900	2,469	635	2,648	3,989	865	7,502
UTAH.....	242	138	74	68	90	258	71	314	340	294	67	262	412	194	868
VT.....	144	108	90	85	46	154	59	85	222	132	50	156	172	124	452
VA.....	1,075	546	368	221	127	950	229	890	1,206	1,096	225	1,101	1,278	566	2,945
VIRGIN ISLANDS.....															
WASH.....	600	433	292	210	151	646	183	882	1,069	784	176	711	1,239	575	2,525
W. VA.....	564	314	216	145	100	450	118	463	592	504	124	703	661	236	1,600
WISC.....	755	561	420	373	180	902	277	523	1,195	926	275	1,019	1,122	587	2,728
WYO.....	91	81	64	58	26	95	43	76	163	114	42	112	146	79	337
TOTAL.....	39,089	24,360	17,406	13,829	9,992	40,677	11,346	36,165	54,860	45,862	11,173	48,814	59,649	25,995	134,458

* Teachers who spend 50% or more of their time teaching Science or Mathematics.

ing data from principals includes the type of school and community, the sex of the teachers, the school enrollment, and the grade levels of the reporting schools. These data will be compiled, reported, and interpreted by the National Science Foundation. Excellent opportunity for research studies using these statistics or questionnaires sent to controlled samplings will develop as we make the U. S. Registry available to graduate students. (See Table I for statistics on science and mathematics.)

Within the grand total of 158,000 teachers are included 48,814 who teach only science and 25,995 who teach science and mathematics. Those who teach only mathematics number 59,649 and approximately 23,000 modern language teachers are reported. These figures are based on reports made by principals of 19,819 public and private secondary schools. Names are continually being added as forms are received in the headquarters office. Those reporting represent 75 per cent of all the secondary schools in the United States; the question remains as to why the other 25 per cent of the principals have not reported and what improvements can be made to have all teachers represented on the registry.

If readers are interested in or have a

need for other tabulations on science, mathematics, or modern language teaching personnel, write to NSTA headquarters asking for registry information.

Research Participation

We are convinced that many science teachers want to do research while they are teaching. Last fall all NSTA members were alerted that the FSAF budget for the current year contained some funds to support research projects, and that research proposals would be accepted. The response to this announcement was gratifying. Late in January a group of research scientists, science teachers, and science educators met in Washington to evaluate the proposals that had been received. Members of the group were pleased with the quality of these proposals, but it was not possible to award grants to all of the applicants. Those to whom support was granted, together with the titles of their research studies, are as follows:

1. Harold L. Eddleman, Salem-Washington High School, Salem, Indiana.

Project: A Search for Mutations in *Tribolium castaneum*.

2. Cyril S. Kaplan, Flushing High School, New York.

Project: Gravimetric Determination

of Complex-Ion Formation in Nitrate Melts.

3. Gerald Mallmann, Fox Valley Lutheran High School, Appleton, Wisconsin.

Project: The Construction of Copper, Cuprous Chloride, Magnesium Batteries.

4. Sister M. Monica Asman, O.S.F., St. Mary's Academy, Winlock, Washington.

Project: The Yellow Fever Transmitting Mosquito, *Aedes aegypti*.

5. Sister M. Stephen McCollum, C.S.J., Luckey High School, Manhattan, Kansas.

Project: General Fallout Patterns of Strontium 90 in the United States in the Early Fall of 1959.

6. George C. Turner, Claremont Senior High School, California.

Project: Professional and Lay Perceptions of Issues Confronting Science Education in the Public Schools.

7. Martin Van Dyke, Denver Christian High School, Colorado.

Project: A Study of the Reaction of Alpha-Benzoin-Phenylhydrazine in Pyridine with Copper Sulfate in Water.

8. Ruth O. Wenner, Lyons Township High School, Western Springs, Illinois.

Project: The Utilization of Certain Amino Acids by *Kloeckera* Yeasts.

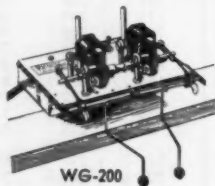
Your students can See wave phenomena with the KINGSTON RIPPLE TANK

PRODUCE WAVES OF VARIABLE FREQUENCY and AMPLITUDE

Produces all types of wave phenomena right in your class room. With the fixed phase wave generator (in circle) you can produce plain or radial waves, differing in frequency or amplitude. Designed for student participation, it is easy to set up, completely safe, rugged, flexible and easy to store. Meets all requirements of the PSSC course. Special barriers to show reflection, refraction, diffraction and interference are available as accessories. 115 volt a.c. plug-in eliminates need for batteries.

AVAILABLE NOW! for the FIRST TIME

VARIABLE PHASE WAVE GENERATOR



WG-200

In addition to waves produced by the RTA-100 described above, the RTA-200 generates 2 radial or 2 plain waves which are out of phase . . . also of different frequencies or different amplitudes.



WG-100



How you may order your apparatus

- RTA-100 Complete fixed phase apparatus . . . \$73.45
- WG-100 Fixed phase wave generator only . . . \$29.75
- RTA-200 Complete variable phase apparatus . . . \$99.70
- WG-200 Variable phase wave generator only . . . \$56.00

f.o.b. Medfield, Mass.

Order now, or write for details on any of the above products



KINGSTON SCIENTIFIC

MEDFIELD, MASSACHUSETTS



BOOK



Reviews

Green Universe. Edward F. Dolan, Jr. 244p. \$3.50. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.

The story of the last complete scientist, Baron Alexander Von Humboldt, and his travels and studies with his companion Aime Bonpland are related in superb narrative, often with true scientific insight on the part of the author. Major episodes include exploration of the Orinoco, the climb of Mount Chimborazo, and the survey of Russia's natural resources. Alexander's friendship with Thomas Jefferson and Simon Bolivar and his snub by Napoleon are treated as if Dolan had been a witness.

Von Humboldt's concern with earth magnetism, vulcanism, and harmony in all nature is carried throughout the story, as is his revulsion against slavery. The book is extremely well written, in warm, flowing style and the reporting factual.

RUBEN PARSON
*Northern Illinois University
DeKalb, Illinois*

Planning and Organizing Science Programs for Elementary Schools. Martha Glauber Shapp. 72p. \$1. The Grolier Society, Inc., 575 Lexington Ave., New York 22, N. Y. 1959.

Many educators are currently developing science programs for the K-6 years. A helpful source of ideas will be found in this teacher's guide to *The Book of Knowledge*. The topics covered are those commonly found in the elementary science curriculum. They are Weather, Living Things Around Us, Our Earth, Beyond Our Earth, Magnetism and Electricity, Transportation, and Communication.

Each subject matter area is organized in a similar fashion. Following the introductory remarks, there is a topical outline of subdivisions of the subject. For each topic, specific references are given to the encyclopedia volumes. There is an indication of the usefulness of the material at the K-3 and 4-6 levels.

The references are followed by a section on "Things to Do" for each major topic.

Suggestions include experiments, demonstrations, collections, construction activities, art work, and reference research.

The classroom teacher will find frequent use for this handy guide if the encyclopedia set is available; it serves as reference to resource material for student and teacher. The outlines of subject matter can be used as guides in unit planning. The "Things to Do" should enrich classroom activities for every teacher.

The publishers have performed a unique service in providing teachers with this easy-to-use guide.

ROBERT A. BULLINGTON
*Northern Illinois University
DeKalb, Illinois*

All About Missiles and Satellites. David Mark. 96p. \$1.50. Cowan Publishing Corp., 300 West 43rd St., New York 36, N. Y. 1959.

The author has performed an excellent job of describing and explaining the basic principles of missiles, satellites, and space travel on a level that is designed to reach the high school student.

This paper-bound book is divided into two sections. The first deals with missiles and their airframes propulsion systems, nose cones, and guidance systems. It also includes a directory that describes and illustrates the various missiles used by the armed forces.

The second part considers the launching of satellites, satellite orbits, how satellites are able to telemeter information back to earth, and the technical terms commonly used in missile and satellite work. It concludes with a review of the outstanding facts about space travel, and the reasons why men are beginning to reach more for the stars and outer space.

Recommended for high school students, their teachers, and their parents.

HAROLD S. SPIELMAN
*Associate Professor of Education
City College of New York,
New York*

90° South. Paul Siple. 384p. \$5.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

The book *90° South* describes the historical background and the building of the American Base at the South Pole. It presents in simple language the human and material aspects of this special International Geophysical Year project. The narrative style employed to portray the sociological, technological, and basic science drama gives to the book a very strong element of human interest. The simplicity with which everyday events are related and interpreted illustrates the literary aptitude of the author and helps the book to be easily understood.

The author gives reality to basic human behavior patterns in describing the camp personnel with the varied backgrounds, education, and ethical codes. The basic principles in human behavior are exposed and made quantitative by the author in the techniques employed to maintain a continuing work program in the face of material, environmental, and humanistic handicaps. The descriptions are both graphic and measurable in portraying the development of mutual collaboration between military and civilian personnel. Keen insight is shown for human emotions when relations between on-the-spot scientific personnel and the administrative scientific personnel back in the States are analyzed.

The very deep academic devotion to polar research assigned to Admiral Richard E. Byrd by the author of this book is symbolic of the kind of human drive and devotion required in many areas of basic scientific research. The contributions for science which were made by the eighteen men who spent the first winter at the American Base at the South Pole are ranked as high among all the accomplishments in science made during the International Geophysical Year. Many details of a scientific nature pertaining to upper atmosphere physics, meteorology, glaciology, geology, oceanography, and astronomy are specifically described.

LOREN T. CALDWELL
*Northern Illinois University
DeKalb, Illinois*

you never outgrow your need for cereal and milk

cereal and milk
for all ages

cereal and milk
for all
for better meals

cereal and milk
for all
for snacks

cereal and milk
for all
for better nutrition

cereal and milk
for all
in recipes

cereal and milk
for all
for economy and convenience

cereal and milk
for all
for tasty, easy combos

april 1-30

7th annual cereal and milk spring festival
cereal institute and american dairy association—sponsors

Free new 8-page, 8½ x 11"
CEREAL GLOSSARY
booklet available.
Includes basic information
on cereal grains,
food value of breakfast
cereals, and nutritional
contribution of cereal and
milk serving.



CEREAL INSTITUTE, Inc.

135 South LaSalle Street, Chicago 3, Illinois

A research and educational endeavor devoted to the betterment
of national nutrition

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
 Northern Illinois University, DeKalb

BOOK BRIEFS

The Fifth Mental Measurements Yearbook.

Oscar Krisen Buros, Editor. 1292p. \$22.50.
 The Gryphon Press, 220 Montgomery St.,
 Highland Park, N. J. 1959.

Critical reviews of tests published since 1952, hence a supplement to the previous Mental Measurements Yearbooks. References to studies and research on the tests are also included, as well as reviews of books in the field of measurement. Reviewers are selected for competency in their fields. An invaluable help in the selection of standardized tests in any field.

The Mammals of North America. E. Raymond Hall and Keith R. Kelson. Volumes I and II. 1194 p. \$35. The Ronald Press Co., 15 East 26th St., New York 10, N. Y. 1959.

An impressive taxonomic reference work describing over 3800 kinds of mammals from Greenland to Panama and to Alaska. Equipped with artificial keys to help with identification of species, along with many distribution maps, numerous drawings of mammals, and details of skull structure. Quality printing throughout in easy-to-read print with a sturdy binding that should stand much use. A valuable addition to the library of anyone who might be dealing with mammalian taxonomy.

Curious Naturalists. Niko Tinbergen. 280p. \$5. Basic Books, Inc., 59 Fourth Ave., New York 3, N. Y. 1958.

An excellent, illustrated, scholarly introduction to the interpretation of animal behavior. Data collected by the author during 25 years of field investigations are presented in nontechnical terms. Orientation, territory formation and defense, protective coloration, life cycles, interrelationships, and other pertinent topics are discussed. Readily understandable by senior high school students and nonprofessional naturalists.

The Human Reproductive System. Third Edition. Thomas H. Knepp. 56p. \$1. Wm. C. Brown Company, 135 South Locust St., Dubuque, Iowa. 1959.

A useful text-booklet for high school students on a subject frequently omitted from biology texts. Developed after many years of experience by the author in teaching the subject in the high school. Text and drawings explain the male and female systems, human embryology, pregnancy, birth, and some aspects of heredity. Paper cover with spiral binding.

Wonders of the Arctic. Jacquelyn Berrill. 94p. \$2.95. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.

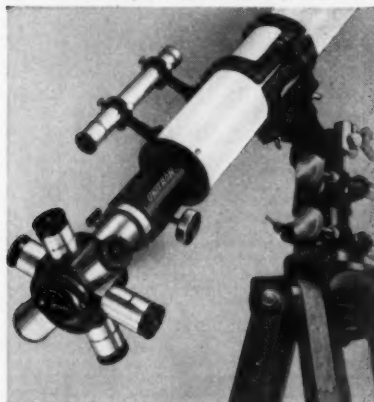
Beginning with a descriptive account of the physical setting of the arctic, the author proceeds to give an interesting account of some of the forms of life found there. Strong features of the book include the biological

THE SKY IS THE LIMIT

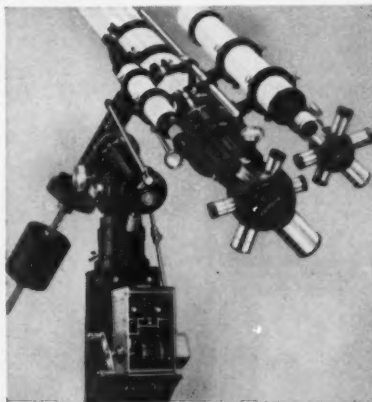
The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age". Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.

In teaching, there is a compelling need to give students an opportunity to do more than just read about the universe.

An astronomical telescope must be capable of resolving pinpoints of light at enormous distances. It, therefore, has to be designed specifically with that objective in view. Highly precise and matched optics are essential to obtain the crystal-clear image definition so necessary for astronomical observations to be meaningful. Mechanical mountings must also be built to close tolerances in order to accurately track a star or planet. You will find all of these requirements superbly matched in a UNITRON.



2.4-Inch ALTAZIMUTH REFRACTOR
MODEL 114—COMPLETE with Altazimuth Mounting and slow motion controls for both altitude and azimuth, tripod, 5X-16mm. view finder, rack and pinion focusing, 4 eyepieces (100X, 72X, 50X, 35X), choice of UNIHEX rotary eyepiece selector or star diagonal and erecting prism system, sunglass, dewcap, dustcap, wooden cabinets, instructions..... **\$125.**



4-Inch PHOTO-EQUATORIAL REFRACTOR
MODEL 166—COMPLETE with Equatorial Mounting and slow motion controls for declination and R.A., setting circles with verniers, clock drive, metal pier, Astro-Camera, 10X-42mm. viewfinder, 2.4" guide telescope, rack and pinion focusing, 9 eyepieces (375X-25X). Super-UNIHEX rotary eyepiece selector, sunglass, solar aperture diaphragm, UNIBALANCE, dewcap, dustcap, wooden cabinets, instructions..... **\$1280.**

UNITRON telescopes are America's largest selling refractors. They have withstood the test of time and are fully guaranteed. There are 16 models to choose from and easy payment terms are available.

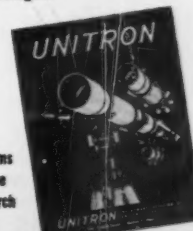
Here is a selection of UNITRON Refractors:

1.6" Altazimuth	\$ 75.00
2.4" Equatorial	\$ 225.00
3" Altazimuth	\$ 265.00
3" Equatorial	\$ 435.00
4" Altazimuth	\$ 465.00
4" Equatorial	\$ 785.00
6" Photo-Equatorial with clock drive and Astro-Camera	\$5660.00

This valuable 38-page Observers Guide and Catalog is yours for the asking! It will help you in the wise selection of a telescope suitable for your needs and at a price to fit your budget.

Contents include—

- Observing the sun, moon, planets and wonders of the sky
- Constellation map
- Hints for observers
- Glossary of telescope terms
- How to choose a telescope
- Amateur clubs and research programs



UNITRON

INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
 204-206 MILK STREET • BOSTON 9, MASS.

Please rush to me, free of charge, UNITRON's new Observer's Guide and Telescope Catalog. Dept. 8-A.

Name _____
 Street _____
 City _____ State _____

SEMI-MICRO FOR SCHOOLS



CENTRIFUGE

COMPLETELY SAFE
for student use.

Interchangeable cast
aluminum head holds
10 x 75 mm tubes and
13 x 100 mm tubes.

No waiting—stop Cen-
trifuge with slight palm
pressure. Silent, rug-
gedly built for long
life.

No. T 3080 Waco
Separator for 100 volt
60 cycle.....\$47.00



SPATULAS

Only 24¢ each



HAND FINISHED Spatulas perfectly shaped
for semi-micro. Corrosion-resistant monel
metal with a red plastic handle. Blade is
slightly dishd with a round bottom.
No. T 10115—Waco Spatulas, monel, 175
mm long, 23 x 5 mm blade tapered to
3 mm tip.

\$3.10 per dozen \$24.00 per 100



HOT PLATE



A 3" personal hot plate
for each student.
Priced under three
dollars. Made to speci-
fications of Dr. L. F.
Fieser for organic semi-
micro. Nichrome ele-
ment and highly con-
ductive aluminum head.
Complete with cord set.

No. T 6612—Waco hot plate.....\$2.95



BURNER



Adjustable Natural and Mixed
Gases.

Both gas and air are adjust-
able for full control of flame.
Nickel-plated brass with flame
stabilizer top. Takes 1/8 wing-
top, burner height 85 mm.

No. T 2627 Waco Burner
.....\$1.80 each

Dozen or more.....\$1.60 each

WRITE FOR FREE SEMI-MICRO Catalog
No. T-3

LABORATORY SUPPLIES AND EQUIPMENT
WILKENS-ANDERSON CO.

4525 W. DIVISION ST. CHICAGO 51, ILL.

comparisons and geographical relationships. These interpretations will enable the student to gain a keener appreciation of the physical and natural features of this important land area. Illustrated with line drawings. Recommended for elementary and junior high students.

Our Space Age Jets. Plastic Magic. Snow Surveyor. Mapping the World. C. B. Colby. 48p each. \$2. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

One author has written four very interesting and informative books for upper grade children. Profuse photographs illustrate each. New and unusual information is revealed.

Our Space Age Jets pictures and describes

23 jet planes, most of recent design. *Plastic Magic* reveals many fascinating kinds and uses of plastics. *Snow Surveyors* is a fascinating account of the little-known work of the men who record the snowfall in our western mountains for the U. S. Department of Agriculture. *Mapping the World* shows how the U. S. Army Corps of Engineers surveys and maps difficult terrain.

1001 Questions Answered About the Mineral Kingdom. Richard M. Pearl. 326p. \$6. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.

The questions and answers in this book are worded for the secondary school student, and are organized by topics under the gen-

OUTSTANDING SCIENCE TEACHERS

Opportunity as of September 1960 for retired high school chemistry and physics teachers with demonstrated background of outstanding ability. Assignments may be rotated each year at various locations near industrial plant cities. Successful candidates would be rated as visiting teachers for nine month school term at excellent remuneration. Program was initiated by Olin Mathieson Chemical Corporation and successfully carried out as pilot operation in Monroe, Louisiana. This program is now being expanded to other locations. It is limited to two classes of fifteen students each and constitutes a college level course for scientifically talented students. Teachers should have the equivalent of a masters degree in the solid subject. This is an exceptional opportunity for those looking for new intellectual stimulation and opportunity. In applying, please send a record of your educational background, experience and a recent photograph.

Write: Mr. Lon H. Colborn
Educational Consultant
312 Normal Avenue
Slippery Rock, Pennsylvania

eral heading of Mineral Kingdom. Some topics covered in typical chapters are minerals and crystals, igneous rocks, precious metals, base metals, iron and ferro-alloy metals, etc. Answers are sufficiently complete to meet most of the needs of students in general education science. Technical terms have been avoided in most cases. Should be a useful reference in any high school science course.

Exploring Biology: The Science of Living Things. Fifth Edition. Ella Thea Smith. 732p. \$5.20. Harcourt, Brace and Company, Inc., 750 Third Ave., New York 17, N. Y. 1959.

A popular high school text has been completely reorganized, rewritten, and greatly expanded with many new illustrations. It is brought up-to-date with much new material. The user will find that most of his favorite topics are included, although many will consider it unfortunate that the space devoted to organic evolution has been drastically reduced. The clearly written text and many excellent supplementary features make this a book worthy of consideration by the teacher.

Wonders of the Deep Sea. Boris Arnov, Jr. and Helen Mather-Smith Mindlin. 96p. \$2.95. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.

This informative book explains in an easy-to-follow style many questions that young people pose about the oceans. It relates how the oceans began and the important role they play in relationship to currents, tides, winds, and waves. Ocean life is interestingly portrayed as well as man's attempt to explore its depths. Descriptive drawings add to the reader's understanding. One should gain an appreciation of ocean resources which are of increasing importance to mankind. Recommended for upper elementary and junior high students.

Wildlife Conservation. Second Edition. Ira N. Gabrielson. 244p. \$5.50. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 1959.

A well-known authority speaks from a lifetime of experience in the problems of preserving our wildlife resources. He stresses the relationships of all forms of wildlife to the conservation of soil, water, forests, and grasslands. A chapter is devoted to the effect of changing agricultural practices upon animal populations. The necessity of balance between productive capacity and harvest of game is emphasized throughout. This readable book is a valuable source of information for any student of biological conservation.

Understanding Chemistry. Lawrence P. Lessing. 192p. 50¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1959.

An interesting account of the role chemistry plays in everyday living written in the language of the layman. Begins with theories relating to the origin of the earth, beginnings of scientific thought, and leads up through

the development of commonplace substances and synthetic materials. Book concludes with a summary of the status of chemistry today and a forecast of things yet to be discovered. For the better high school student. A Mentor Book, paper cover.

Science Since 1500: A Short History of Mathematics, Physics, Chemistry, and Biology. H. T. Pledge. 358p. \$1.85. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1959.

The original publication of *Science Since 1500* is now twenty years old—having been published at the outset of World War II. This book's coverage of a subject so impossibly vast and complex must necessarily be selective. For instance, theory largely

adumbrates application. Spotty treatment of the biological sciences is illustrated by the excellent analysis of nineteenth-century evolution without similarly considering the relationship of cytology, genetics, and systematics to twentieth-century evolution. A book of greater importance to the physical scientist than to the biological scientist.

All About Archaeology. Anne Terry White. 148p. \$1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y. 1959.

The fascinating work of the archeologist as a detective of time is vividly portrayed. Methods of operation, dating techniques, and civilizations of the past interestingly described. Ancient Greece, Troy, palace of Minos, pyramids of Egypt, Incas, Aztecs, and

there is one high school physics text written for the space age

BASIC PHYSICS

by Dr. Alexander Efron, Stuyvesant High School, N.Y.C.

Atom age physics—not Newtonian age physics in keeping with today and tomorrow's needs for instruction in science

Basic Physics is a thoroughly modern text with a new teaching approach offering an enriched course in intermediate physics for high school and junior college students. High school students using Efron's Basic Physics have done exceptionally well in Regents' Examinations.

In addition to the classical subjects, these are some of the vital, modern, up-to-the-minute subjects comprehensively covered in Efron's Basic Physics . . . Does your present text deal adequately with them?

• "Anatomy" of Solids • Surface Energy in Liquids • Heat: Energy in Transit • Temperature: an Energy Level or "Hill" • Graphics of Heat Exchange • Heat Carriers and Heat Transport • Cryogenics • Pressure: a Scalar Quantity • Extremely High Pressures • Penetration of the Ionosphere • Vacuum Engineering • "Geometry" of Sound • Psychophysics of Sound • Hearing, Speech, and Music • Principle of Least Time in Optics • Directional Light Control • New Theories of Earth's Magnetism • Ferrites and Ferroelectrics • Magnetic and Electrostatic Domains • B-H Curve; Hysteresis • Ultrasonics • Oxidation-reduction Processes in Electric Cells • Motor action: Deflection of Electrons in a Magnetic Field • Traveling and Standing Sound Waves • Huyghenian Wave-Front Construction • New Derivation of Lens Formula • Dioptric Power • New Language of Illumination • Interference of Waves • "Line", "Area", and "Volume" Light Sources • Composition and Resolution of Vectors by Trigonometry • Exponential Notation (Powers of 10) • Circular Motion: Kinematics and Dynamics • The MKS System of Units • Graphics of Motion • Wind Tunnels and Mach Numbers • Heat-Engine Principles and Schematics • Reaction Engines • Voltage as Work per Unit Charge • Non-"Hydraulic" Treatment of Current • The Anode-Cathode Controversy • Graphics of Electrical Resistance • Mechanics of Induction • Circuits, Vectors, and Mathematics of Alternating Currents • Polyphase A.C. • Rectifiers • Transistors and Solar Battery • History of Subatomic Particles • Research and Power Reactors • Atomic Submarines • Thermonuclear Reactions • Advanced View of the Atom • Rockets, Missiles, and Satellites

HIGH SCHOOLS WITH THE HIGHEST STANDARDS OF PHYSICS INSTRUCTION HAVE ADOPTED BASIC PHYSICS—HERE ARE JUST A FEW

Milford High School, Milford, Conn. E. O. Smith High School, Storrs, Conn. Suffield Academy, Suffield, Conn. Pompano Beach High School, Pompano Beach, Fla. Palm Beach Jr. College, Lake Worth, Fla. South Broward High School, Hollywood, Fla. West Point Public Schools, West Point, Ga. Austin High School, Chicago, Ill. Community High School, West Chicago, Ill. Monmouth High School, Monmouth, Ill. Francis W. Parker School, Chicago, Ill. West High School, Rockford, Ill. Elkhart High School, Elkhart, Ind. Ames Community School District, Ames, Ia. Hebron Academy, Hebron, Me. Friends School, Baltimore, Md. Board of Education, Baltimore County, Towson, Md. Baintree High School, Baintree, Mass. Longmeadow High School, Longmeadow, Mass. Mendon High School, Mendon, Mass. Military Academy, Milton, Mass. Roxbury Latin School, Roxbury, Mass. Tanasqua Regional School District, Sturbridge, Mass. Noble and Greenough School, Dedham, Mass. Milton Academy, Milton, Mass. Detroit County Day School, Birmingham, Mich. A. B. Davis High School, Mount Vernon, N. Y. Fieldston School, New York, N. Y. Forest Hills H. S., Forest Hills, N. Y. Fulton H. S., Fulton, N. Y. Andrew Jackson H. S., Cambria Heights, N. Y. New York Trade School, New York, N. Y. The Nichols School, Buffalo, N. Y. Peekskill Military Academy, Peekskill, N. Y. Julia Richman High School, New York, N. Y. The Walden School, N. Y. C. Thomas A. Edison Vocational H. S. (Jamaica), N. Y. Stuyvesant H. S., N. Y. C., and many others.

#195, 2 vols. in one cloth binding, 724 pp., 800 illust., \$7.60 list.

BRILLIANTLY CONCEIVED LABORATORY WORKBOOK FOR BASIC PHYSICS.

PHYSICS QUESTIONS & PROBLEMS—with answers by Dr. Alexander Efron.

Lists more than 600 important problems and answers for use in conjunction with BASIC PHYSICS. #195-3, \$1.50.

Send for review copies on 30-day approval. At end of 30 days you can either remit price of book or return it without cost.

SCHOOL DISCOUNTS APPLY

Dept. ST-3



JOHN F. RIDER PUBLISHER, INC.

116 West 14th Street, New York 11, N.Y.

**For a sound foundation
in science**

SCIENCE TODAY AND TOMORROW

By Gerald S. Craig and ten teacher-specialists in science

With the books of this outstanding series in authentic science, boys and girls are given a real opportunity for learning through reading, doing experiments, discussing, and observing.



Excellent Teachers' Editions provide experiments, suggestions for presenting the subject matter, and background material.

Books for grades 1-8.

**Be sure to write for more
information.**

GINN AND COMPANY

Home Office: BOSTON
ATLANTA 3

Sales Offices: NEW YORK 11
DALLAS 1 PALO ALTO

CHICAGO 6
TORONTO 16

Mayas are among the discoveries treated. Illustrated with black and white drawings. Recommended for elementary and junior high groups.

Seeing the Earth from Space. Irving Adler. 160p. \$3.50. The John Day Company, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

Gives detailed knowledge of the information discovered thus far in the space programs. Develops the story of space exploration by simply covering the principles of rocketry, the earth satellites, and rocket programs. Two-thirds of book devoted to explanations of the findings about the earth and near space discovered by the space probes. Well written for junior high students and also useful for senior high study of space. Illustrated with photographs and drawings.

How Old Is the Earth? Patrick M. Hurley. 160p. 95¢. Anchor Books, Doubleday & Company, Inc., Garden City, N. Y. 1959.

Portrays man's attempt to date the earth and traces the methods of dating. Includes chapters on the earth's structure and beginnings. Well written. Suitable as reference and interest reading for senior high and college students and adults. Illustrated.

Men, Moss and Reindeer: The Challenge of Lapland. Erick Berry. 96p. \$2.50. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

The upper grade reader will enjoy this story of the Lapps and their complete de-

"HOW TIMES HAVE CHANGED"

Not so long ago you would have had to pay at least
\$250.00 for this

EXCELLENT MICROSCOPE

TODAY only \$63.00 will bring this FINE instrument to you on a "FULLY GUARANTEED" and "MONEY BACK BASIS"

DEFINITELY A MUST IN EVERY SCIENCE CLASSROOM

FEATURES INCLUDE:

ACHROMATIC OBJECTIVES
COATED LENSES
SAFETY STOP (to prevent damage to slides as well as objectives)
DISC DIAPHRAGM (for correct LIGHT)
COARSE ADJUSTMENT
FINE ADJUSTMENT
DE-LUXE CARRYING CABINET

EYEPIECES	OBJECTIVES	MAGNIFICATIONS
10X and 5X or 15X	10X and 40X on Double DUSTPROOF Nosepiece	50X to 600X

Quantity Discounts Available on Request

THE Lumiscope COMPANY
836 Broadway, N.Y.C. 3, N.Y.
Send FREE COLOR CATALOGUE To:

Name
Address
City State



MODEL 4

THE *Lumiscope* COMPANY

836 Broadway, New York 3, N. Y.

pendence upon their reindeer herds and the moss upon which the animals feed. Rigors of the Arctic winter and the nomadic life of the summer are well told. Has many fine photographs.

Albert Einstein. Arthur Beckhard. 126p. \$2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

A well-written biography of the life of Einstein suitable as enrichment reading for junior high school students. Explains his life, his interests, and how he developed his theories. Illustrated with sketches.

The Young Inventors' Guide. Raymond F. Yates. 104p. \$2.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1959.

A book for the young inventor. Describes inventors, and inventions of the past that have reaped rewards for their creators. Contains suggestions for protecting an invention; how a patent should be obtained; cost of obtaining a patent; and how to market an invention, once a patent has been granted.

All About Prehistoric Cave Men. Sam and Beryl Epstein. 138p. \$1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y. 1959.

Discusses life of early men, who they were, and how they lived. Peking Man, Neanderthal Man, and Cro-Magnon are described. Discoveries of both professional and amateur archeologists interestingly portrayed. Illustrated with drawings. Recommended for elementary and junior high groups.

Making Electricity Work. John M. Kennedy. 214p. \$3.50. Thomas Y. Crowell Company, 432 Fourth Ave., New York 16, N. Y. 1959.

Explains electricity in terms easily understood. Especially suited for junior high students who are interested in the whole field of electricity. Covers circuits, magnetism, motors, and generators. Ideas for things to build and things to do. Illustrated.

The Chemical Elements. Helen Miles Davis. (Revisions by Glenn T. Seaborg.) 204p. 50¢. Science Service, Inc., 1719 N. St. N. W., Washington 6, D. C., or Ballantine Books, Inc., 101 Fifth Ave., New York 3, N. Y. 1959.

The authoritative and fascinating story of man's discovery of each of the building blocks of the physical universe. Excerpts from the original publication in the discoverer's own words are included. This is the revised edition of a successful book which has had wide usage. It should prove a valuable aid to teachers who wish to add historical flavor to their discussions. A highly readable handbook which should prove useful to student and teacher alike.

Water—Or Your Life. Revised Edition. Arthur H. Carhart. 322p. \$4.50. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa. 1959.

Every student of conservation should have access to this hard-hitting and authoritative

discussion of our national water problems. The well-qualified author stresses the importance of this natural resource and reveals the difficulties, arising from many conflicting interests, of controlling its use. Little changed from the 1951 edition except for a new closing chapter telling of the great strides in water use and pollution control made in the last decade.

Men, Planets, and Stars. Clyde B. Clason. 160p. \$2.95. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

Brief survey of the developments in astronomy from the time of the Babylonians to the present. Presents an accurate description of our system. Famous astronomers are cited in the presentation of the material. An intro-

duction is given to the field of discoveries in spatial relationships. For junior high school.

Exploring Physics. New Edition. Richard F. Brinckerhoff, Judson B. Cross, and Arthur Lazarus. 732p. \$5.20. Harcourt, Brace and Company, Inc., 750 Third Ave., New York 17, N. Y. 1959.

The outstanding characteristics of this high school text are: (1) its more than usual comprehensive preview of the year's work in the first two chapters, (2) its use of excellent two-color diagrams, (3) its inclusion of stimulating material for the better students, suggestive of the possibilities of further reading from other sources, and (4) the comprehensive material at the end of the book, including formulas, a mathe-

SCIENCE ELECTRICITY

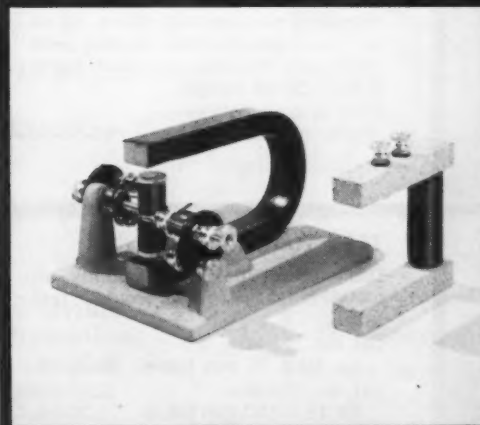
by **SESCO** INC.



ELEMENTARY SCIENCE ELECTRICITY

A complete science package for the elementary level. Includes all necessary parts and apparatus to perform both the teacher demonstrations and the student activities outlined and illustrated in "Electricity and Magnetism"—Atkin and Burnett, published by Rinehart and Company, Inc. Includes magnets, switches, lamps, batteries, buzzer, motor-generator, telegraph demonstrator, telephone demonstrator, meter, compasses, plus the many miscellaneous parts shown.

Kit No. 71A complete with manual "Electricity and Magnetism"—Atkin and Burnett
\$89.50



ST. LOUIS TYPE MOTOR-DEMONSTRATOR

Radical improvement in efficiency permits operation on ordinary flash-light cells.

Adjustable brush holders, heavy cast aluminum base, low current drain are only a few of the features of this versatile rugged unit.

Detailed instruction sheets permit a comprehensive study of motor and generator principles.

Complete with permanent magnet and electro-magnet field.

No. 7001 \$14.50

AVAILABLE UNDER NDEA

OTHER RINEHART PUBLICATIONS BY ATKIN AND BURNETT AVAILABLE FROM SESCO:
Working with Animals • Working with Plants • Air, Winds and Weather

SESCO INC

Subsidiary of Universal Scientific Co. Inc.
1312 South Thirteenth Street,
Vincennes, Indiana

matics course in outline for those with inadequate background, tables of physical and mathematical constants, and samples of questions from the advanced placement examination in physics. This text is comprehensive and accurate. Physical concepts are carefully explained in a correct manner. Contains a brief explanation of the atomic basis for understanding chemical changes, which is not usually included in a physics course.

Satellites and Space Probes. Erik Bergaust. 48p. \$2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

Describes the satellite and space programs of the world. Up-to-date pictures and data. Contains information on the present and future

programs of the United States and Russia. Excellent photographs and explanatory drawings. Suitable for upper elementary and junior high reading.

Everyday Life in Prehistoric Times. Marjorie and C. H. B. Quennell. 226p. \$3.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

An excellent portrayal of prehistoric man's way of life, based upon archeological findings. Traces man's development of early culture through tools, clothing, and shelter. Covers early man from *Pithecanthropus* to the Celts of England. Interestingly written. Well illustrated with photographs and drawings. Suitable for junior-senior high students and for general reading.

PROFESSIONAL READING

"Teaching Machines." By Jesse H. Day. *Journal of Chemical Education*, 36:591. December 1959. Teaching machines require the active participation of the learner at all times. In this way they differ from other teaching devices. Examples are given of how the machine can be used with a complete description of what a teaching machine is and some of its misuses.

"Teaching Techniques in the Undergraduate Organic Laboratory." By S. J. Storfer and E. I. Becker. *Journal of Chemical Education*, 36:614. December 1959. The substitution of the "discovery" technique for "cookbook" methods in the organic laboratory is discussed.

"Evaluation of High School Physics Courses by College Students." By Haym Kruglak. *American Journal of Physics*, 27:630. December 1959. College physics students were asked to complete a questionnaire about their high school physics course. The study was done to identify outstanding physics teachers and their methods. Interesting topics, such as the value of the physics course for college preparation, are also discussed.

"The Prehistory of the Periodic System of the Elements." By Jan. W. con Spronsen. *Journal of Chemical Education*, 36:565. November 1959. Teachers of chemistry will find that much historical information in this article will enrich a discussion of the history and formulation of the periodic system of the elements. Describes scientists (and their activities) responsible for developing the foundations for the periodic law in an interesting and concise manner.

"The Flow of Matter." By Marcus Reiner. *Scientific American*, 201:122, December 1959. Solids, as well as liquids and gases, flow. In some respects, gases behave like solids. This article explains these two paradoxes.

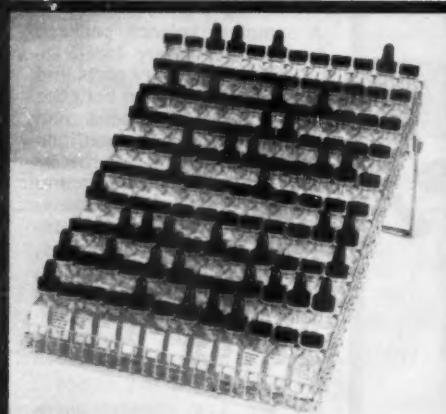
"The Invention of the Electric Light." By Matthew Josephson. *The Scientific American*, 201:98. November 1959. Edison's electric light was "... an idea not a thing." Explains the economic, technological, and sociological changes that this invention caused. The historic diagrams and schematic circuits will be very interesting to science historians.

"Ninth Grade Biology—Pros and Cons." By William W. Sharken. *School Science and Mathematics*, 59:718. December 1959. Discussions of arguments for and against moving biology into the ninth grade, and of the few which are backed up by evidence. Research studies are stressed to throw more light on the problem.

"Methods of Presenting a One Year Integrated Science Course." By F. C. MacKnight. *School Science and Mathematics*, 59:730. December 1959. Presentation to show science as a whole, rather than to emphasize the identity of its divisions. Several approaches are: (1) a sequence of merging topics, (2) a chronological one, (3) a geological one, (4) a philosophy of science approach, (5) a case

SEMI-MICRO APPARATUS

by **SESOCO** INC.



TILTRAY

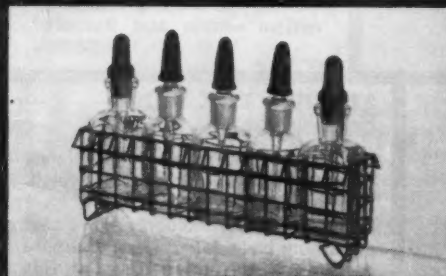
The only reagent tray which stores flat but tilts for handy access and label visibility. All metal construction, coated with chemically resistant plastisol. Holds 120 each 15 ml bottles, dropper type or square.

Tray without bottles—

Cat. No. 120M \$4.85 ea.

Tray complete with 120 bottles and labels for "Semi-micro Chemistry" DeBruyne-Kirk-Beers published by Henry Holt.

Cat. No. 290 13.25 ea.

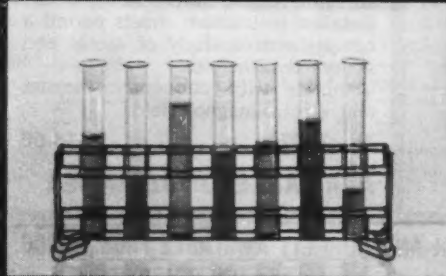


ACID-BASE REAGENT TRAY

No more seepage and stains. Open, all metal construction, coated with chemically resistant plastisol. Holds 5 each 30 ml bottles.

Tray without bottles—

Cat. No. 221M \$1.50 ea.



TEST TUBE RACK

Designed for maximum visibility—all metal, plastisol coated. Holds 7 test tubes.

Cat. No. 113M

for 10 x 75 mm tubes . . \$1.20 ea.

Cat. No. 119M

for 13 x 100 mm tubes . . 1.30 ea.

Cat. No. 122M

for 15 x 125 mm tubes . . 1.40 ea.

SESOCO INC.

Subsidiary of
Universal Scientific Co. Inc.
1312 South Thirteenth Street,
Vincennes, Indiana

method approach, or (6) a combination of 1-5.

"High School Students Evaluate Sectioning." By H. J. Klausmeier, John Mulhern, and Howard Wakefield. *Educational Leadership*, 17:221, January 1960. The results of the study described were in favor of ability grouping. Indicates that students of low ability were getting less out of school in terms of their social and academic needs than other students.

AUDIO-VISUAL AIDS

Solutions. 16 min. **Ionization.** 18½ min. **Nitric Acid Compounds and the Nitrogen Cycle.** 18½ min. These three films are part of the set of 18 in the new Coronet Chemistry Film Set which covers the topics usually included in high school chemistry. Each film treats the principles related to the topic and presents demonstrations and laboratory experiments. Filmed with cooperation of Wheaton College. Available as a set or singly, in color or black and white. Price (available on request) depends upon length. 1959. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Aristotle and the Scientific Method. A valuable addition to the available films on the scientific method. Dramatization presents a chronological story of the development of ideas concerning the nature of the universe. The story culminates in the observations of Aristotle and his contributions to the scientific method. For senior high science, especially biology. 13½ min. Color \$137.50, B&W \$75. 1959. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Isaac Newton. Filmed in England in locales associated with Newton. Good for historical interest, general information on achievements of Newton, and inspiration. Recommended for secondary mathematics and physics. 13½ min. Color \$137.50, B&W \$75. 1959. Coronet Instructional Films, Coronet Buildings, Chicago 1, Ill.

Galileo. A brief story of the major achievements of the great scientist portrayed by actors in settings in Italy. Shows how some of his contributions to science came about, and stresses his problems in fighting tradition. A stimulating film for junior and senior high students of general science and physics. 13½ min. Color \$110, B&W \$60. 1959. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

What's Inside the Earth. A generalized examination of the sedimentary rocks of the crust, inferred composition of the earth's mantle, and determination of the structure of the central core from seismic data. Equipment used for this investigation is shown in operation, giving the student an opportunity to see earth dynamics in action. Produced for use in earth science studies at the elementary

and junior high schools. 13 min. Color \$135, B&W \$70. 1959. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

APPARATUS & EQUIPMENT

Project-O-Stand. A unique device that will enable the teacher to assemble his own microprojector by adding 300- or 500-watt, 35-mm slide projector and monocular compound microscope. The image is projected

upon a ground glass screen with a magnification about twice that observed in the microscope. For use on demonstration table in front of class. Folds into compact size for storage. No. CI-1, \$49. 1960. Central Custom Instrument Company, 539 Lincoln St., Algonquin, Ill.

Laminated Anatomy Study Cards. These cards should be a great help to the student of anatomy. They are clear, exact, and complete. Each card has a legend associated with numbers on the drawings. Most practical for the college student but also useful in high school biology. Cards should be of value in connection with dissection. Set 1: *Bones, Muscles and Muscle Insertions*, 21 cards. \$2.50. 1956. Set 2: *Arteries, Veins, Nerves*



with Nystrom Models, Charts, Globes and Maps

ELIGIBLE FOR PURCHASE UNDER PROVISIONS OF THE NATIONAL DEFENSE EDUCATION ACT . . . TITLE 3.

MODELS—Anatomy . . . Biology

CHARTS—Anatomy . . . Biology . . . General Science . . . Physiology

GLOBES—Physical . . . Celestial . . . Satellite . . . Planetarium . . .
Globe-Reading Activity Cards

MAPS—Physical . . . Rainfall . . . Thermal . . . Outline

For further information, return this convenient coupon today.

FREE!
N. D. E. A.
CATALOG

Please send me your catalog No. ST360, with full-color illustrations, descriptions and prices of Nystrom science materials.

NAME _____
SCHOOL _____ POSITION _____
ADDRESS _____

A. J. NYSTROM & CO.

3333 ELSTON AVENUE
CHICAGO 18, ILLINOIS

and *Lymphatics*, 21 cards. \$2.95. 1958. Set 3: *Cat, Necturus, Frog and Shark*, 21 cards. \$2.50. 1959. Student Merchandise, Inc., 350 Fifth Ave., New York 1, N. Y.

Bausch & Lomb Student Microscope, Model ST-22. A new model to replace the former model FL. The ST-22 has improved optical and mechanical features. The general appearance is very similar to that of the older model. \$125 each (1-4); \$112.50 (5 or more). Bausch & Lomb Optical Company, Rochester 2, N. Y.

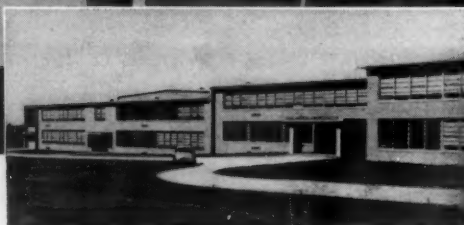
Bausch & Lomb Stereozoom Microscopes, Model BVB-73 and SVB-73. Sturdily constructed microscopes with the interchangeable

"power pod" feature which allows any of the optical units to fit any of the stands. The two models differ only in the stands. BVB-73 has an ordinary rack and pinion stand with a stage and a substage base; SVB-73 has the rack and pinion mounted on a boom extending from a vertical post and heavy base. Either stand seems to work very well for the routine work. The Stereozoom feature works well and is clearly a major improvement in microscope design and construction, particularly in that it eliminates the chance of "losing" the specimen while changing magnification. Model BVB-73, \$385 each (1-4); \$346.50 (5 or more). Model SVB-73, \$414.50 each (1-4); \$373.05 (5 or more). Bausch & Lomb Optical Company, Rochester 2, N. Y.

"BEST POWER SUPPLY for science experiments"



Mr. William Fischer, science department head, demonstrating electroplating with a Lab-Volt unit.



Middletown Township High School (west wing), Middletown, N. J.

"**Lab-Volt** POWER STATIONS have really proved themselves here" reports Bill Fischer, head of the science department at Middletown High School.

"More than a year of heavy usage has proved to us that Lab-Volt Units are the best means of supplying A.C. and D.C. power for our electrical experiments. Not one malfunction has occurred to slow us down, and savings over other permanent power supply systems have completely equipped our labs with top quality apparatus such as that in the photo. I do not hesitate to recommend Lab-Volt Power Stations as the wholly practical and economical solution to the problem of supplying variable A.C. and D.C. power for science labs."

See Lab-Volt at Kansas City, Booth No. 21

➔ FREE TEACHING AIDS . . . Sample illustrated experiments available on request.

Write for complete **Lab-Volt** catalog today.



BUCK ENGINEERING COMPANY, INC.

36 MARCY STREET, FREEHOLD, NEW JERSEY • FREEHOLD 8-1111

Index of Advertisers

Addison-Wesley Publishing Company, Inc.	46
Albert Teachers' Agency	32
Alden Products Company	67
American Optical Company	38
Bausch & Lomb Optical Company	50
Bell Telephone Laboratories	13
Buck Engineering Company, Inc.	82
Cambosco Scientific Company	40
Central Scientific Company	4, 28, 36
Cereal Institute, Inc.	74
Clay-Adams, Inc.	14
Denoyer-Geppert Company	70
Doerr Glass Company	62
Pat Dowling Pictures	41
Edmund Scientific Company	66
Elgeet Optical Company, Inc.	56
Field Enterprises Educational Corporation	Cover II
Fisk Teachers Agency	35
Ginn and Company	78
Harcourt, Brace and Company, Inc.	64
Harvard Apparatus Company, Inc.	63
D. C. Heath and Company	34
Indiana University NET Film Service	65
Kewaunee Technical Furniture Company, Kewaunee Manufacturing Company	17, 18
Kingston Scientific	72
J. Klinger Scientific Apparatus	35
E. Leitz, Inc.	44
The Lumiscope Company	78
Olin Mathieson Chemical Corporation	76
McGraw-Hill Book Company, Inc.	1
National Science Teachers Association	Cover III
The New American Library	52
A. J. Nystrom & Company	81
Ohaus Scale Corporation	Cover IV
Pickett & Eckel Company, Inc.	68
Prentice-Hall, Inc.	33
Product Design Company	25
Rand McNally & Company	42-3
John F. Rider Publisher, Inc.	77
Science Kit, Inc.	47
Science Materials Center	25
The L. W. Singer Company, Inc.	54
Spitz Laboratories, Inc.	45
Swift Instruments, Inc.	37
Testa Manufacturing Company	22
Unitron Instrument Division, United Scientific Company	60-1, 75
Universal Scientific Company, Inc.	79, 80
D. Van Nostrand Company, Inc.	30
W. M. Welch Scientific Company	2
Wesleyan University	26
Wilkens-Anderson Company	76



Do **YOU** Have These NSTA Publications?

Designed and published especially for science teachers; geared to make a contribution to your classroom teaching.

Let's Build Quality into Our Science Tests

Emphasizes the importance of achievement in aspects of critical thinking; includes examples of tests for use in teaching or evaluation; prepared under direction of NSTA's Committee on Evaluation in Science Teaching. 1958. 25p.... **\$1.00**

Science in the Junior High School

Report of conference held by NSTA's Future Scientists of America Foundation and co-sponsored by Oregon State College and the Crown Zellerbach Foundation; recommendations developed by conference team of 32 selected teachers of junior high school science. Illustrated. 1958. 22p. **\$1.00**

Proceedings of NSTA's Seventh National Convention

Includes major addresses, and summaries of discussion groups, parallel sessions, and symposia which carried out the theme "Science Education for America: An Appraisal and a Look Ahead." 1959. 56p. **\$2.00**

Analyses of Science Tests

An evaluation of standardized tests in general science, physics, biology, and chemistry. Compiled by NSTA's Committee on Evaluation in Science Teaching. 1959. **50¢**

Science for the Academically Talented Student

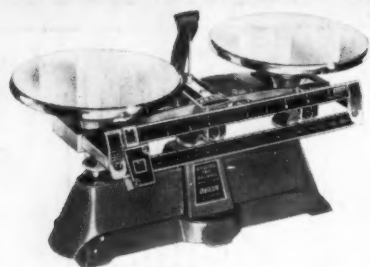
Report of a Conference sponsored jointly by the National Education Association Project on the Academically Talented Student and the Future Scientists of America Foundation of the National Science Teachers Association. Contains chapters on identification, course content, and teaching methods. 1959. 64p. **\$0.60**

SEND ORDERS TO:

(Checks payable to National Education Association)

**Publication-Sales Section
National Education Association
1201 Sixteenth Street, N. W.
Washington 6, D. C.**

DISCOUNTS on quantity orders of the same publication shipped to one address, unless otherwise specified, are as follows: 2 to 9 copies, 10%; 10 or more copies, 20%; flat rate to bookstores and other agencies for resale, 20%.

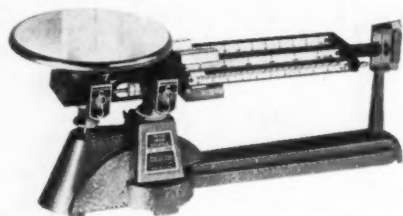


list price
\$24.00

HARVARD TRIP BALANCE

Model No. 1550-S

Capacity 2 Kilogram
Sensitivity 0.1 Gram

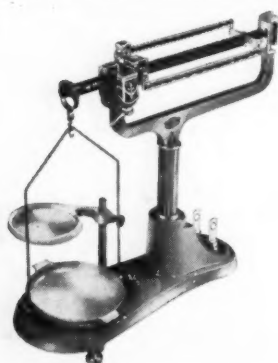


list price
\$20.50

TRIPLE BEAM BALANCE

Model No. 750-S

Capacity 2610 Gram
Sensitivity 0.1 Gram



list price
\$31.00

CENT-O-GRAM TRIPLE BEAM BALANCE

Model C.G. 311

Capacity 311 Gram
Sensitivity 0.01 Gram

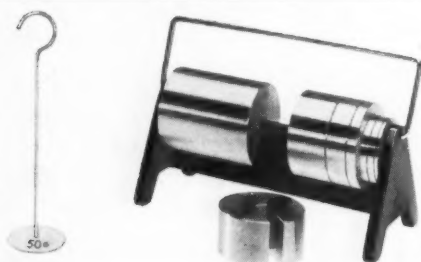


list price
\$4.25
\$5.00

STO-A-WEIGH WEIGHT SETS

Available in Class C, Q, or P Adjustment.
Shrinkproof box with Stainless Steel Forceps.

Model 5210.... 50 Gram x 10 Mg....Class C
Model 5211....100 Gram x 10 Mg....Class C



list price
\$9.50

list price
\$1.00

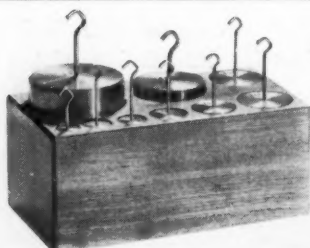
BRASS SLOTTED WEIGHT SET

Model No. 43503

500 Gram x 10 Gram with Weight Rack

WEIGHT HANGER

Model 46207 50 Gram



list price
\$12.50

METRIC HOOK WEIGHT SET

Model 46206

1000 Gram x 10 Gram

Lacquered Brass Weights in Hardwood
Block

A COMPLETE LINE OF
balances and weights for the
School Science Program

SEE OUR DISPLAY AT THE NATIONAL
SCIENCE TEACHERS ANNUAL CONVENTION

OHAUS
SCALE CORPORATION
1050 COMMERCE AVE.
UNION, NEW JERSEY

for complete information write for **FREE** bulletin